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UNDER THE GENERAL EDITORSHIP OF
CHALMERS WATSON, M.B., F.R.C.P.E.

VOLUME X

PREGNANCY TO *SCARLET FEVER*

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THE AUTHORS OF THE PRINCIPAL ARTICLES ARE AS FOLLOWS:—

Pregnancy—

Affections of Ovum and Decidua.—W. E. Fothergill, M.D., B.Sc., Manchester.

Diseases of Placenta and Cord.—T. W. Eden, M.D., M.R.C.P., Assistant Obstetric Physician, Charing Cross Hospital, London.

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Affections of the Ovum and Decidua.

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The nomenclature of the subject is so varied that a short restatement of the structure of the ovum and decidua during early pregnancy is needed in order to avoid repeated definitions in the course of the following discussion.

The lining membrane of the uterine cavity consists of a delicate stroma containing round connective tissue cells. This tissue is placed directly upon the uterine muscle, is richly supplied with small blood-vessels, and is perforated by numerous pits or crypts. Its free surface is covered by a single layer of columnar epithelial cells, which dips down into and lines completely the crypts, follicles, or glands of the uterine mucosa. It is this membrane which, during pregnancy, undergoes certain definite changes and forms the decidua. While the mucosa is about $\frac{1}{20}$ in. thick just after menstruation, it grows until it is about $\frac{1}{6}$ in. thick before each menstrual flow begins. When pregnancy begins and arrests menstruation, the lining of the uterus continues to grow until it reaches its maximum thickness of about $\frac{1}{3}$ in. during the third month of gestation. The so-called glands dilate, and the blood-vessels also enlarge and multiply. The round connective tissue cells proliferate rapidly, and many of them increase greatly in size and assume irregular shapes, thus becoming the "decidual cells" characteristic of the mucosa of pregnancy. These decidual cells are most numerous near the free surface of the membrane, which soon loses its covering of epithelial cells. The epithelium lining the glands also degenerates, and for the most part disappears, except from their deepest portions, where it remains alive in sufficient quantity to secure the regeneration of the epithelium of the whole uterine cavity after the end of pregnancy. Three layers can be recognised in the uterine mucosa as modified by pregnancy: (1) A superficial compact layer, with many decidual cells lying between the glands, which are not much dilated, but whose epithelium is flattened, degenerated, and largely lost; (2) A spongy or reticulated layer, whose glands are very widely dilated, and their epithelium much degenerated, some decidual cells, and many spindle cells and fibrils of connective tissue occupy the spaces lying between the dilated glands; (3) A deep layer of delicate connective tissue containing the undilated blind ends of the glands, whose epithelium is unchanged. On examining a pregnant uterus at any time before the end of the third month we find that a uterine cavity still exists, and is lined completely by decidual mucosa. The ovum lies embedded in the compact layer of the decidua on one wall of the cavity, its whole surface being in contact with the decidual connective tissue, and not with maternal epithelium. The decidua underlying the ovum—*i.e.* between it and the uterine wall—is called the decidua serotina, and is the site of the developing placenta. That covering the ovum, and lying between it and the uterine cavity, is the decidua reflexa. The rest of the decidua lining the uterine cavity, and not at first touching the ovum, is the decidua vera. During the third month the ovum, covered by the decidua reflexa, begins to occupy the whole space within the uterus. The reflexa and the vera now come into close contact, obliterating the uterine cavity. The two become adherent, and blend into a single layer of tissue. After the third month the decidua becomes less vascular and pale in colour; it is flattened out and thinned by the pressure of the growing ovum. Fatty and other degenerations occur in the decidual cells. The vessels become thrombosed by the proliferation of their endothelium, and before full time is reached the decidua is reduced to a thin and unimportant layer of maternal tissue covering the ovum, and coming away with the secundines at parturition by separation through its superficial layer, leaving the deep layer with the embedded ends of the uterine glands as the sole covering of the muscular wall of the uterus. The ovum and decidua can most readily be studied by examining "complete abortions" expelled about the end of the second month of pregnancy. Such specimens consist of the ovum enclosed in the decidua. On removing the decidual covering (decidua vera and decidua reflexa, with the remains of the uterine cavity between them being recognisable as a rule) the ovum itself is seen to be a sac covered all over with shaggy branching processes, the villi of the chorion. On opening the sac its cavity is seen to contain a little liquor amnii and the fœtus, while it is lined by the thin smooth amnion, which can easily be stripped from the thicker outer membrane, the chorion, which bears the villi on its outer surface. To understand the structure of these fœtal membranes, a portion of the wall of the ovum with the decidua attached should be sectioned for microscopic examination. The amnion is then seen to consist of two layers, the inner one being a single layer of epithelial cells (fœtal epiblast), while its outer stratum is of delicate connective tissue (fœtal mesoblast). The chorion is also composed of two layers, the inner of connective tissue, the outer of epithelium. The connective tissue layers of amnion and chorion are in contact with, and indeed continuous with, one another. (See Figs. 1 and 2.)

The fœtal epiblast, or chorionic epithelium, forming the outer stratum of the chorion, is a layer two cells thick. Each chorionic villus is an outgrowth of the chorion, being composed of a core of embryonic or mucous connective tissue covered by a layer of fœtal epithelium which is, like that of the chorionic membrane, two cells thick. The mesoblastic core of the villus is continuous with the connective tissue layer of the chorion, and contains capillary loops filled with fœtal blood corpuscles. The appearance of the surface of the decidua shows that the fœtal epithelium has the power of eating into and so destroying the maternal tissues. By this phagocytic action of their epithelium the tips of the villi penetrate and become attached to the compact layer of the decidua. By this means also the decidual blood-vessels are opened into and thrown into communication with the space between the chorion and the decidua which is crossed by the villi, so that the maternal blood circulates freely in the intervillous space. In many specimens it is possible to distinguish two cell layers in the fœtal epithelium covering the chorion and its villi. The outer layer shows no cell outlines, and it consists of a stratum of protoplasmic material containing numerous nuclei and

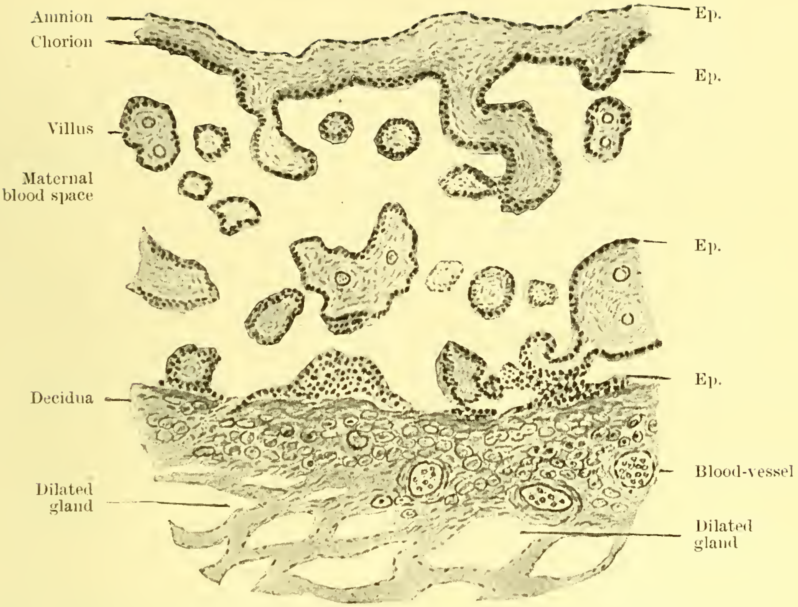

FIG. 1.—Section through wall of early ovum (about 3 weeks) and decidua. Drawn from nature. Zeiss ½ in. ob. oc. 3. Ep. = fœtal epithelium.

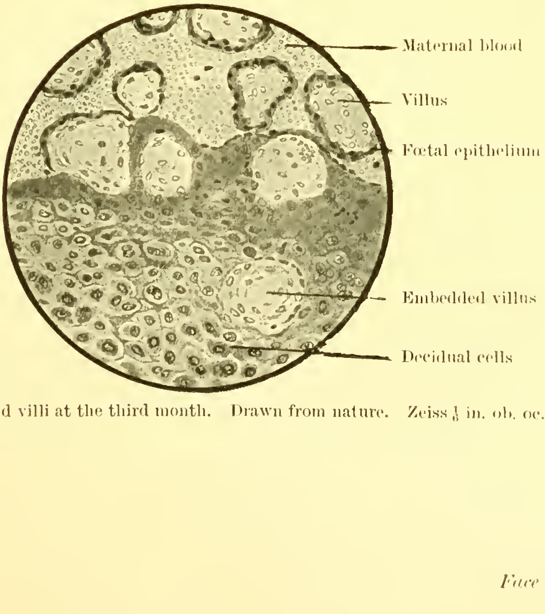

FIG. 2.—Decidua and villi at the third month. Drawn from nature. Zeiss ⅙ in. ob. oc. 2.

vacuoles. This outer layer of the chorionic epithelium is known as the "syncytium." The inner layer, which is in contact with the connective tissue of the villi and chorionic membrane, consists of distinct cells of large size, and is known as the "layer of Langhans."

In order to understand the affections of the amnion, it is needful to remember that although the amniotic epithelium appears in transverse sections as a layer of apparently cubical cells, the appearance of the amnion when "silvered" and viewed in surface is closely suggestive of a serous membrane. The epithelial cells are flat and irregular in outline, while numerous stomata or openings between the cells are visible on careful examination.

Affections of the Decidua

Hypertrophy of the Decidua.—The changes that occur in the endometrium during early pregnancy are mainly hypertrophic in nature, and, like other physiological hypertrophic changes, they are liable to exceed normal bounds and become pathological. Diffuse hypertrophy of the decidua consists in a general overgrowth of the maternal covering of the ovum. If slight, this condition simply leads to the production of a decidua which is thicker than usual at the end of pregnancy. If excessive, it may result in abortion at any period of gestation, but usually does so at the second, third, or fourth months. Microscopic examination reveals the presence of an excessive number of decidual cells, the connective tissue is unduly soft and yielding, and the vascular spaces are unduly large. Hæmorrhage occurs into the decidua or into the ovum itself on causes slighter than those necessary to produce it under normal conditions. Congestion due to backward pressure from cardiac lesions, coitus, the action of purgatives, and other slight accidents are liable to thus bring about the death of the ovum, more especially at times corresponding to the menstrual periods.

Polypoid Hypertrophy of the Decidua.—Virchow has described this condition under the name of *endometritis decidua polyposa vel tuberosa.* The whole decidua is thickened, but very unevenly, its surface being raised into polypoid excrescences, between which the openings of the uterine glands may be observed. The tissue is very vascular, and is rich in decidual cells. The condition is sometimes found, as in Virchow's case, in connection with syphilis, and generally with a persistent endometritis. Müller states that the chorionic villi frequently show myxomatous change. This condition affects early ova and ends in abortion, which occurs from the second to the fourth month.

Atrophy of the Decidua.—Spiegelberg, Priestley, and others have described atrophy of the decidua, causing the ovum to be attached by a pedicle instead of being embedded in a continuous layer of maternal mucosa. This condition, by lessening the support usually provided for the delicate membranes of the ovum, has resulted in rupture of its sac through the thinned decidua reflexa.

Inflammation of the Decidua.—Inflammatory changes in the decidua follow, as a rule, persistent endometritis. If acute, they tend to produce early abortion; and if chronic, they tend to cause fibrosis, undue firmness and toughness of the tissues which attach the ovum to the uterine wall. The result of this is difficulty in separation of the ovum from its bed. If expulsion of the ovum is premature, incomplete abortion occurs; if it is deferred till term, adherence of the placenta or membranes, or both, complicates the third stage of labour. Purulent inflammation of the decidua, due to microbic infection, has been described by Donat. A placenta expelled at term brought with it decidual masses infiltrated with pus, and purulent fluid was collected between the amnion and chorion, which were thickened and opaque.

The symptom known as hydrorrhœa gravidarum is due in some cases to a catarrhal inflammation of the glandular elements of the decidua following a chronic catarrhal endometritis affecting the epithelial linings of the uterine glands. Fluid containing mucus is secreted in excess, and accumulates between the decidua and the chorion. It may escape either in gushes or by a slow dribbling during the later months of pregnancy. This condition must not be confused with gradual escape of the liquor amnii, nor with cases in which this fluid collects between the amnion and the chorion, escaping suddenly on rupture of the latter membrane.

Leopold has demonstrated the occurrence of small cysts in the decidua of young ova, caused by the retention within the uterine glands of the secretion during early pregnancy. During the course of various infectious fevers, which frequently cause abortion, the decidua undergoes acute inflammatory and hæmorrhagic changes, which are held to be the means by which abortion is produced. Klotz has described these changes as they occur in measles, and Slavjanski records a condition of hæmorrhagic decidual endometritis in cholera. The decidua was thickened, dark purple in colour, and full of extravasated blood.

Syphilis has been found to exist in connection with almost every form of decidual disease; but there is nothing accurately known as to its effects on the decidua beyond the fact that it frequently causes abortion.

The above-mentioned affections of the decidua are seldom if ever diagnosed, and they admit of no treatment. While of pathological interest they have no clinical importance except in so far as they affect the nature and management of the abortions they cause. They are indirectly causal of many sequelæ of abortion and parturition.

Hæmorrhage.—Hæmorrhage into the decidua, however, sometimes causes the death of the ovum, followed by its prolonged retention in utero and its final expulsion in the form of a fleshy or bloody mole (see also "MOLE, MOLAR PREGNANCY," vol. viii.).

Fleshy or Carneous Mole.—When the ovum dies without the occurrence of hæmorrhage, and is then retained for a time in utero, it shrinks and undergoes fatty degeneration, being ultimately expelled as a shrivelled mass known as a "blighted ovum." When, however, bleeding occurs into the decidua, the intervillous space is distended, the decidua is more or less broken up. The subchorionic hæmatoma thickens the wall of the ovum and causes the chorio-amniotic membrane to be thrown into convolutions, which project as bosses and tuberosities into the amniotic cavity. Some specimens have been described in which the amnion was separated from the chorion by blood-clot, the hæmatoma being subamniotic as well as subchorionic. The maternal blood occasionally breaks into and clots within the amniotic cavity itself.

The structure of the mole depends upon the age of the ovum at the time of its death, and upon the quantity and position of the blood-clot which is formed in and around it. Thus if the ovum dies before the formation of the placenta, and when the whole chorion is covered with villi, the whole wall of the ovum is thickened by the formation of blood-clot between the villi. If the placenta is already formed it becomes curled round on itself, so that its uterine surface forms the external surface of the mole, the membranes being crumpled up within its concavity. Again, if the hæmorrhage is sufficient to separate the decidua completely from the uterine wall, the structure of the mole differs from that found in cases where the decidua remains in contact with the muscular wall of the uterus.

Morgani is the earliest writer who shows a clear understanding of the morbid anatomy of retained apoplectic ova. Writing before the year 1859, Scanzoni states that the thickness of the chorion in these cases is due to the effused blood, more or less organised, which is found between the villi. This, he continues, becomes transformed into connective tissue, which becomes vascular and adheres to the uterine wall. Breus has made microscopic examinations in five cases. Berry Hart and the author have also described the histological changes observed. After the death of the ovum and the stoppage of the chorionic circulation the small fœtal vessels in the villi disappear, the larger ones being more slowly obliterated, and leaving for some time a few blood crystals and amorphous granules to mark their late position. The fœtal connective tissue between the epithelial layers of the amnion and the chorion, as also that forming the cores of the villi, is compressed, but is not otherwise altered for a long time. The fœtal epithelium lining the amniotic cavity also remains recognisable, but the outlines of its cells are lost, and the nuclei become clouded. The fœtal epithelium of the chorion and the chorionic villi undergoes similar changes. When this epithelial covering of the villi degenerates after the stoppage of the fœtal circulation, the maternal blood in the intervillous spaces does not long continue to move, but soon forms a firm blood-clot embedding the villi. This intervillous blood-clot consists so largely of fibrin that it seems probable that the degenerated epithelium of the villi acts as a foreign body, layer after layer of fibrin being deposited upon the villi from the maternal blood until the whole intervillous space is thrombosed. Eden has shown that this occurs in parts of the living placenta which lose their fœtal blood-supply towards the end of normal pregnancy.

As the liquor amnii is absorbed the subchorionic hæmatoma bulges inward into the cavity of the ovum, throwing the amnion and chorion into the characteristic bosses or elevations which are seen on cutting into the ovum, and laying open its amniotic surface. If recurrent hæmorrhages into the decidua separate the ovum completely from the uterine wall, the outer surface of the mass comes to be formed by concentric layers of blood-clot, and the tissues of the ovum may remain much as described above until the whole mass is expelled, it may be months after the death of the ovum.

In other cases the decidual hæmorrhage, while sufficient to kill the ovum and form the subchorionic hæmatoma, does not separate the ovum from the decidua by a thick layer of blood-clot, but leaves the mass of villi embedded in fibrin still in contact with the uterine wall. In such cases further changes are caused by the continued life and growth of the decidua. The decidual cells continue to multiply, and, exercising a phagocytic action, they attack the fibrin, the chorionic epithelium, and ultimately the connective tissue cores of the villi, making an attempt to convert the mass into tissue of the nature of decidua. This action of the decidual cells in organising masses of retained placenta has been described by Hartmann and Toupet, and they have applied the name *Deciduoma benignum* to a placental polypus thus converted into connective tissue. It is worthy of note that Cazeaux, Naegele, Osiander, and others, believe that complete absorption of placental structures by the uterine mucosa has occasionally occurred. For the retention of dead ova in the uterus during long periods the absence of septic infection is a necessary condition.

Two factors are concerned, as a rule, in the production of these molar pregnancies. On the one hand is decidual disease, which renders extravasation of blood more liable to occur; and on the other hand there is usually some general condition which favours pelvic congestion. Such are cardiac lesions, traumatism, prolonged exertion, and the exanthemata. For the retention of the ovum it is essential that the uterine cavity remain free from septic infection.

Symptoms and Course.—The usual symptoms and signs of pregnancy appear and progress normally up to a certain point, they then pass away and leave the patient with amenorrhœa or with irregular vaginal discharges, sometimes resembling menstrual blood, but at other times consisting of mucus stained brown with blood pigments. The breasts cease to enlarge, and shrink to their original size. Pain, as a rule, is absent, though there may be down-bearing, backache, and general malaise. The uterus becomes firmer in consistency than in normal pregnancy, the cervix losing its characteristic softening. The organ may remain the same size, may grow slowly, or may gradually lessen. For repeated hæmorrhages may increase its size by adding layer after layer of blood-clot to that already surrounding the retained ovum; or, in the absence of fresh hæmorrhage, the absorption of the liquor amnii may cause reduction in the bulk of the mass. Expulsion finally occurs spontaneously and accompanied by more or less pain and bleeding. Some ova have been retained in utero as long as eighteen months, but expulsion more often occurs within a much shorter time.

In the diagnosis of this condition everything depends upon the recognition of pregnancy, as, apart from this, the practitioner will be confused by thinking in turn of all the recognised causes of uterine enlargement. Given, however, a clear history of commencing pregnancy, followed either by a threatened abortion or by gradual disappearance of the signs and symptoms of pregnancy, there is still room for dubiety in many cases. It may be difficult, if the uterus continues to enlarge, to be sure that the fœtus is really dead, and Simpson points out the danger of interference in such cases, lest, while one of twins has perished, the other should be still alive. Vesicular degeneration of the chorion may also be suspected under these circumstances. If the uterus is decreasing in size it may be difficult to prove that any product of conception is still within it. Indeed, it is often impossible to ascertain the true condition of affairs until careful observation has been continued over a period of several weeks or even months.

The prognosis is good, as there is little disturbance of health as a rule, and the bleeding which occurs on expulsion is seldom severe. There is always the risk of sepsis, and there is always a marked tendency to subinvolution, the uterus remaining large and flabby much longer than after an ordinary abortion. In a few cases the condition known as deciduoma malignum has followed the expulsion of retained ova.

Owing to the difficulty in diagnosis, the management of the cases recorded has almost always been expectant. If, however, the condition is clearly recognised, the cervix should be partly dilated, and uterine contraction should then be secured by packing the vagina, or distending it with a rubber bag. The mole having been expelled naturally, or the uterus having been cleared out by hand, special precautions against subinvolution should be taken. Rest in bed, hot douching, and the exhibition of strychnine, iron, quinine, and hydrastis are of value in the after treatment.

The blood mole, or mola hæmatomatosa, is simply a variety in which blood-clot forms the bulk of the mass. The fibrinous mole of Berry Hart appears to be due to disease of the chorion, and is accordingly referred to under that heading.

Spurious Abortion.—This term has been applied by Eden to a condition of which he has described three examples. It is supposed than an ovum is fertilised, and develops far enough to set up the changes in the endometrium which usually accompany gestation. The ovum perishes at such an early date that it leaves no trace of its existence, but the decidual membrane goes on growing for two or three months, accompanied by amenorrhœa, enlargement of the uterus, enlargement of the breasts, and morning sickness. Brownish discharge or bleeding is then followed by the expulsion of a decidual cast of the uterus, similar to those expelled in cases of ectopic gestation, and containing no fœtal elements whatever.[1]

The cast is triangular in shape, and consists of a sac formed entirely of uterine mucosa, which has undergone the changes mentioned in describing the development of the decidua. Without careful investigation these casts would be mistaken for early abortions, and they are probably more common than is supposed. Whenever such a cast is expelled it is necessary to make sure that ectopic pregnancy does not exist, in order that the patient may be promptly treated for that condition if necessary.

This condition cannot be diagnosed clinically, and demands no treatment until expulsion of the cast occurs, when recovery is rapid and complete.

Malignant Disease of the Decidua.—No account of the affections of the decidua would be complete, in the present state of our knowledge, without reference to the form of malignant disease which is known (amongst other names) as deciduoma malignum. For although Veit and several British authorities hold that this condition is sarcoma of the uterus, existing before, but modified by the occurrence of pregnancy, a number of observers believe that the new growth begins in the decidua itself, is essentially a disease of pregnancy, and cannot be pre-existent to its occurrence.

This view was taken by Sänger, who first described a case in 1888. He considered it to be a sarcoma derived from the decidual cells during pregnancy, and later suggested the name sarcoma-deciduo-cellulare as more descriptive than deciduoma malignum.

The great majority of observers on the continent of Europe and in America, together with some British authors, hold that the growths in question are not sarcomata of maternal origin, but are fœtal carcinomata derived from the chorionic epithelium. Having regard to the opinion of the majority of observers at the present time, the condition is described under the heading "Affections of the Chorion" (*infra*). See also "PUERPERIUM—Pathology," p. 178.

AFFECTIONS OF THE CHORION

Vesicular or Hydatidiform Degeneration (Hydatid Mole).—In this condition there is a rapid increase of the connective tissue cells in the stroma or core of each chorionic villus affected. This occurs not continuously, but at intervals, so that a series of swellings is formed along the stem and branches of the villus. The connective tissue forming these swellings then undergoes myxomatous degeneration, the central cells are separated by clear fluid, and later disappear, each swelling thus becoming a small cyst whose wall consists of a thin layer of connective tissue covered by the chorionic epithelium. Concurrently with the cyst-forming degeneration of the mesoblastic cores of the villi, there is also great activity on the part of their epithelial covering, large masses of proliferating syncytium being seen in all sections of hydatid moles. This overgrowth of fœtal epithelium, with its phagocytic action on the maternal tissues, accounts for the unusual depth to which the diseased villi penetrate the uterine wall, and the unusual firmness with which the degenerated chorion is attached. The decidua is usually thickened, some of the cysts being completely embedded within it, while others may invade and even completely perforate the muscular wall of the uterus. The characteristic "hydatid" appearance of the degenerated chorion when expelled follows from the transformation of each villus into a branching string of cysts, varying in size from that of a pin's head to that of a gooseberry.

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[1] The author has, since the above was in print, described a case in which a uterine cast of this kind was expelled after eight weeks' amenorrhœa, together with a small body, the size of a split pea, which proved to be a complete ovum of about five days' growth.—*Trans. Obstet. Soc. London*, 1901.

The change is generally so early in date as to affect the whole chorion, causing the death and complete absorption of the embryo, and the transformation of the whole ovum into a mass of cysts. In rarer cases the degeneration begins later and does not affect the whole chorion. In these instances the remains of the fœtus may be found. In a few cases in which a living child has been born at term, vesicular degeneration has been observed in portions of the placenta.

The frequency of hydatid mole is estimated by Norris and Dickinson at 1 in 20,000 pregnancies. There were 10 cases in 24,500 pregnancies observed at St. Bartholomew's Hospital. Other authors place its occurrence at 1 in 2000 cases. The condition may complicate pregnancy at any age, and cannot be proved to be more frequent in advanced life. It has been said to be rare in primiparæ, and that it tends to follow a series of rapidly recurring pregnancies, but these statements are not supported by facts. It sometimes occurs twice or even three times in the same patient. For this reason, amongst others, the disease is held by some to be of maternal origin, and this view is probably correct, especially as a living child has occasionally been born with part of its placenta in a state of vesicular degeneration. An abnormal condition of the decidua probably permits of overgrowth and subsequent degeneration of the chorion, which in turn kills the fœtus, unless the change begins late and affects only a limited portion of the decidua. It is worthy of note that about half the recorded cases of chorioma malignum have occurred after hydatid degeneration of the chorion, a fact which suggests that the two conditions have a common cause. According to the author's observations, the decidual cells normally exercise a phagocytic action upon the fœtal epithelium, checking undue invasion of the uterine wall by the chorionic villi. If this view is correct, any disease of the decidua which prevented the development of the decidual cells or interfered with their phagocytic action would admit of abnormal growth and activity on the part of the chorionic villi, and would thus afford a primary factor in the causation of both vesicular degeneration of the chorion and of the so-called chorioma malignum, if we suppose that this new growth is indeed composed of fœtal elements.

In the early weeks of pregnancy nothing abnormal is observed. Morning sickness is frequent, the breasts enlarge and are tender. The cervix softens at the usual time, and purple discoloration of the vagina is observed in most cases. Amenorrhœa is complete, as a rule, for some months; but irregular discharges of blood may occur for some time before the hydatid mole is expelled. The fœtal heart may be heard in cases in which the onset of the degenerative process is late, and uterine souffle is occasionally observed; but both these signs are absent as a rule. Uterine enlargement is abnormal, in most cases being much more rapid than in normal pregnancy, while the organ has a softer and more "boggy" consistency than usual. In certain cases, however, the ovum is cut off from the uterine wall by extravasated blood, but is retained in the uterus. Shrinking then occurs, and the uterus remains smaller than it would be at a corresponding period of normal pregnancy, just as in the case when a fleshy mole is retained. In such cases the uterus is firmer to the feel than usual. The rhythmical contractions which characterise the gravid uterus are almost always absent. The attention of the patient is generally attracted by irregular hæmorrhages and the escape of watery blood-stained discharge, which sometimes contains vesicles detached from the chorion, and has then been described as resembling red currant juice with white currants floating in it. The mass is generally expelled before full time is reached, its separation being rendered difficult by the deep penetration of the degenerated villi into the maternal tissues, and their consequent firm attachment. The same circumstances often cause the expulsion of the mole, to be accompanied by severe hæmorrhage, and also favour the occurrence of septic infection and of subsequent subinvolution.

The diagnosis depends upon the recognition of the symptoms and signs of pregnancy followed by the disappearance of these, with the exception of enlargement of the uterus. The growth of the uterus must then be observed, and if it is not proportionate to the advance of time the presence of vesicular degeneration must be suspected. The occurrence of irregular bleeding confirms the suspicion, which may be rendered a certainty by the appearance of vesicles in the discharges. In the absence of a clear history and of vesicles in the discharge, there is difficulty in distinguishing the condition from accidental hæmorrhage (see page 70), and it has also been confused with placenta prævia and with hydramnios. It is impossible to distinguish from fleshy mole a hydatid mole which has been retained dead in utero until shrunken and firm. True hydatid cysts have occasionally discharged their contents through the uterus or vagina, but in such cases a careful examination of the structures discharged at once reveals their true nature.

The prognosis in vesicular degeneration of the chorion is always grave, as deaths from hæmorrhage, anæmia, septicæmia, and pyæmia are frequently recorded. These, as well as perforation of the uterus, are favoured by the deep penetration of the uterine wall and the consequent firm attachment of the mole. Dorland estimates the mortality at 18 per cent. The prognosis must be considered still more grave in view of the fact that more than half the recorded cases of deciduoma or chorioma malignum have followed vesicular degeneration of the chorion.

The uterus should be emptied as soon as the diagnosis is made, or before this can be done if bleeding is severe. If dilatation of the cervix has commenced, packing the vagina with gauze, or distending it with a rubber bag, may be sufficient to ensure expulsion of the mass. Otherwise tents may be used, with strict antiseptic precautions. It is important to secure complete dilatation, uterine contraction, and natural expulsion of the mass when possible. In any case, it is necessary to ascertain by digital examination that the uterine cavity is thoroughly clear, carefully avoiding injury to the uterine wall, and thereafter to take every precaution against septic infection and against subinvolution.

Myxoma Fibrosum.—This name was applied by Virchow to a rare form of degeneration of the chorion, which results in the production of solid masses of fibro-myxomatous tissue instead of the more familiar cysts. Proliferation of the connective tissue cells of the cores of the villi is followed by some degree of fibrous change, the villi forming solid rods. The epithelium remains for the most part unchanged. This condition may be seen in the same specimen, together with cystic degeneration; and it may also occur in portions of an otherwise healthy placenta, as happened in Virchow's case.

Berry Hart has described a case of "fibrous mole," which was probably due to prolonged retention *in utero* of an ovum which had undergone fibromyxomatous degeneration. A patient had a threatening of abortion at the third month, and thereafter had slight occasional hæmorrhages during nine months, at the end of which she expelled a pear-shaped mass measuring 4½ by 2½ inches. On section this was seen to be composed almost entirely of a white glistening mass, coarsely granular, with a small amniotic cavity at the lower end, but no fœtus. On microscopic examination the mass was seen to be made up of hypertrophied villi, the cores of which were made up of wavy fibrous tissue, with very few corpuscular elements, and hardly any vessels. Where the villi were not in contact with one another, their epithelium was fairly well preserved, but at other places the villi, intervillous spaces, and decidual cells were blended, the fœtal epithelium being lost and the decidual cells well preserved. The intervillous spaces contained fibrin.

Epithelioma of the Chorion, or Chorioma Malignum (*Syn.:* Syncytioma malignum).—The authors who have described cases of malignant disease under the above names consider the neoplasm in question to be composed of fœtal epiblast, that is, of chorionic epithelium, which, they hold, invades the uterine tissues, and continuing to grow within the maternal organism, produces a new growth with metastatic deposits. For this reason, a description of the condition must be included amongst those of affections of the chorion. It has been mentioned above that other authorities consider similar, if not identical, new growths to be sarcomata of maternal origin (see "Deciduoma Malignum," vol. x. p. 178).

Clinical Features.—Parturition (in a few cases), abortion, or expulsion of a hydatid mole (in more than half the recorded cases) is followed by profuse intermittent hæmorrhages and enlargement of the uterus, which usually begin a few weeks after the emptying of the uterus. In a case recorded by Whitridge Williams, bleeding was absent, the appearance of metastases first calling attention to the condition. In those of Runge, Löhlein, and others, the bleeding was delayed for some months. The hæmorrhage causes profound anæmia, and putrid discharge of a watery character follows septic infection of the growth. Fever and cachexia supervene, metastases appear in the vagina, cervix, and pelvic organs, and also in the lungs, liver, brain, kidneys, and other viscera. Death is usually caused by septicæmia, or by pulmonary or cerebral complications due to metastasis, and occurs as a rule within six or seven months of the beginning of the disease, which is thus the most rapidly fatal of all known malignant growths.

The uterus generally contains irregular masses of new growth of very soft friable consistency, composed largely of blood-clot and necrotic tissue, and varying in colour from grayish red to dark purple. The growth involves the muscular wall of the uterus, and sections of it show, besides blood and debris, cell elements of two kinds, and occasionally complete chorionic villi. The cell elements are (1) large individual cells, round, oval, polygonal, or spindle shaped, with large nuclei and clearly defined protoplasm; and (2) irregularly shaped masses of vacuolated material containing numerous nuclei, but showing no cell outlines. The metastases in other parts of the body present the same appearances. The spread of the disease is mainly by the blood stream. Schmorl reported a case which he considered to be of this nature, in which the uterus was not affected; and Davis and Harris have described a case in which abortion was induced for pernicious vomiting, the uterus being curetted, and being then healthy. The patient soon died of general carcinomatosis, which the authors consider to be chorioma malignum, although the uterus was found perfectly healthy at the autopsy.

It will be remembered that the fœtal epiblast, as observed in the epithelium of the young chorion and its villi, consists of two layers, which, though not often so distinct in nature as in the figures of some authors, are easily recognisable in favourable specimens. These are (1) a layer of nucleated protoplasm known as the syncytium, and (2) a layer of large cells with distinct outlines known as Langhans' layer. These, it is said, are the physiological prototypes of the elements of the so-called chorioma malignum, the irregular plasmodial masses seen in that growth being supposed to be derived from the syncytium, while the individual cells are the pathological derivatives of the cells of Langhans' layer. The appearances presented by the chorionic epithelium in hydatid mole are said to present a transition stage between the normal chorion and the malignant new growth. In the cases of Schmorl and of Harris and Davis above mentioned the fœtal epiblastic structures are said to have passed through the uterine wall and entered the maternal circulation, filling the maternal organism with deposits of malignant new growth, yet leaving the uterus itself perfectly healthy. Whether these two cases are accepted or not, the fact remains that the chorionic origin of the majority of the recorded cases is believed in at the present time by most writers on the subject.

The diagnosis is easy. Whenever pregnancy, more especially molar pregnancy, is followed by repeated bleedings and persistent discharge, the uterus should be examined, and scrapings from its interior should be submitted to microscopic examination. The characteristic appearances of sections at once make clear the nature of the case.

The prognosis is absolutely bad, unless surgical treatment is undertaken at an early date. If the uterus is removed, the patient has a very fair chance, recovery having occurred in about one-third of the cases recorded. In most of these the uterus was removed before metastases had appeared. In several cases, however, recovery has followed hysterectomy, although metastases were present, the extravasation of blood around these having apparently destroyed their nutrition and life. The treatment consists in hysterectomy performed as soon as possible after the diagnosis is made, as any waste of time in curetting and other partial measures may be fatal to the patient's chances of recovery.

AFFECTIONS OF THE AMNION

The pathology of the amnion is best understood when it is regarded as a serous membrane, liable to variations in its powers of secretion and absorption, and also to inflammations which may cause it to throw out exudates which may be plastic as well as serous.

Hydramnios (*Syn.:* Polyhydramnios, hydrops amnii).—The accumulation within the amniotic cavity of an excessive quantity of liquor amnii may begin at any time during pregnancy. If slight in degree, it causes no symptoms, and may pass unnoticed even during labour. If more pronounced, it may attract attention and demand treatment many weeks before term. At the end of pregnancy the quantity of liquor amnii usually varies between one and two pints, but the condition is seldom noticed unless two quarts or more are present. Quantities of fluid such as six gallons have been removed from the uterus at term. If the accumulation is rapid instead of gradual, the condition is known as acute hydramnios, and presents a much more striking clinical picture than the more familiar variety.

The fluid may be derived from the serum of the maternal blood, as is shown by the occurrence of hydramnios together with other serous effusions. It may also be due to the increased secretion by the amnion of fluid derived from the fœtal blood. This may be caused by any circumstance which raises the blood pressure in the umbilical vein, such as disease of the liver in syphilitic fœtuses, and twists or knots in the cord. Excessive secretion of urine by the fœtus and abnormal perspiration through the fœtal skin are mentioned by various authors as causes of hydramnios. Inflammation of the amnion has also been regarded as a cause of excessive secretion. Tarnier and other authors hold that deficient absorption of liquor amnii, rather than its excessive production, is the true cause of the condition.

The symptoms and signs of pregnancy appear in regular order, but the uterus enlarges more rapidly than usual. The fœtal heart sounds may be inaudible, and, in extreme cases, it may be impossible to recognise the presence of a fœtus even by ballotement. When the uterus much exceeds its normal size, pressure symptoms are produced, the principal being shortness of breath, cyanosis, and abdominal distress. The more rapidly the distension occurs, the more severe are the symptoms—pain, dyspnœa, cyanosis, and vomiting appearing in quick succession in acute cases. The child is often delicate or diseased, and often presents club-foot, spina bifida, or other deformities. Labour is very often premature. (For the effect of hydramnios upon labour see "LABOUR, PATHOLOGY OF," vol. vi.).

The diagnosis of hydramnios should not be difficult when once the fact of pregnancy is firmly established. Even then it is necessary to use care in distinguishing hydramnios from some other complications of pregnancy. Thus ascites with pregnancy must be recognised by percussion made with the patient lying on the side, when the flank will be resonant as a rule. Cystic tumours with pregnancy will be recognised on palpation as separate swellings, although a large ovarian or parovarian cyst with a small pregnant uterus may afford a veritable diagnostic puzzle. Distension of the bladder during pregnancy is recognisable by the use of the catheter. Twin pregnancy can usually be distinguished from hydramnios by palpation of the fœtal parts. If the fact of pregnancy cannot be clearly established, the diagnosis of hydramnios may, however, be very difficult indeed. The treatment of hydramnios during labour is mentioned elsewhere (see "LABOUR, PATHOLOGY OF," vol. vi. p. 212). If serious symptoms are produced before the child is viable, there need be no hesitation as to rupturing the membranes, as the child is so often deformed, diseased, or dead under these circumstances that the prolongation of pregnancy should not be allowed at any risk to the mother.

Oligohydramnios.—Deficiency of liquor amnii causes certain modifications in the course of labour (see "LABOUR, PATHOLOGY OF," vol. vi.), and in the very early portion of pregnancy it is said to favour the formation of adhesions between the amnion and various parts of the fœtus.

Inflammation of the amnion, with plastic exudation, is a more definite cause of adhesions between the amnion and the skin of the fœtus which may seriously impair the development of the latter. The adhesive material may become stretched as growth goes on, so forming non-vascular bands which stretch or constrict fœtal structures. Amongst deformities in whose causation inflammation of the amnion plays a part may be mentioned exomphalos, anencephalus, dwarfing of limbs, and intra-uterine amputations. Leopold mentions that the cord may be involved in amniotic adhesions, which may thus cause the death of the fœtus.

Rupture of the amnion may occur, the chorion remaining complete. The membranes may then be separated, and the amnion may be rolled up into bands which may become entangled with the cord, and may so interfere with the fœtal circulation.

Cysts have been found within the substance of the amnion, but these are small in size, and have no effect upon the course of pregnancy or of labour.

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Diseases of Placenta and Cord

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THE subject of the diseases of the placenta has hitherto obtained very little systematic attention. The normal structure of the organ at different stages of development has only in recent years been clearly defined, and the systematic study of its pathology has therefore been hardly practicable. Many of the earlier accounts of pathological conditions must be rejected, because such conditions are now known to result, not from disease, but from the normal processes of maturation and senescence. A short account of these normal processes will therefore rightly precede the consideration of the diseases of the placenta.

CHANGES DUE TO RIPENING.—Certain well-defined changes occur in all healthy placentæ during the last two or three months of gestation. In their nature they are uniform, but in their extent they present great divergences in different cases, divergences which cannot at present be adequately explained. Stated briefly these changes consist in the occurrence of obliterating endarteritis in a variable number of the middle-sized branches of the fœtal arteries, and in widespread changes resulting therefrom in the affected areas, the most important of which are the formation of numerous solid patches in the spongy placental substance, termed *infarcts*, and the deposition of large quantities of fibrin from the maternal blood upon the villi in the affected parts. Necrosis rapidly destroys all the structural characters of these villi.

In this manner the maternal and fœtal circulations become obliterated in many small areas of the placenta, and numerous groups of villi are rendered functionless. Well-marked changes of this character can be detected in practically all ripe, healthy placentæ, but the amount of placental tissue thus destroyed varies greatly. The marginal cotyledons are usually much more affected than the central ones. Degenerative changes also occur in the serotina during the same period.

These conditions have frequently been erroneously attributed to placentitis, to hæmorrhage, to syphilis, to phthisis, etc., etc.; they are, in reality, due to old age, and are probably preparatory to the normal process of shedding during labour. The young placenta is certainly less easily separated from the uterine wall than the fully ripened organ, and the presence or absence of the changes described probably explains this difference. It is possible also that these changes determine the onset of labour by gradually rendering the placenta inadequate to the further nutrition of the fœtus.

POST-MORTEM CHANGES (RETAINED PLACENTA).—When the fœtus dies, and the ovum is not at once discharged from the uterus, certain changes occur in the placenta as the result of the suspension of the circulation through it. The fœtal circulation is, of course, at once suspended; the maternal circulation through the inter-villous spaces fails gradually; fresh blood may be found between the villi here and there in placentæ which have been retained for several weeks after the death of the fœtus. The villi are nourished directly by the maternal blood which surrounds them, and where the maternal circulation has remained active they show no degenerative or necrotic changes. Where the circulation fails the inter-villous spaces become obliterated by coagulation of the blood they contain, and the villi in those parts rapidly necrose. The changes they undergo are similar to those found in infarcts in living placentæ, except that obliterative endarteritis is not present; fatty degeneration is very marked in these villi.

A great deal of the pathological work which has been done with the placenta has been undertaken in the case of retained placentæ. Insufficient acquaintance with the normal post-mortem appearances has led to these changes being described as the cause of the death of the fœtus, whereas in reality they have resulted from it. In this manner a great deal of confusion has been introduced into the subject.

PUTREFACTION.—Dead placental tissue when retained in the uterus is especially liable to the attacks of putrefactive organisms. This is a very common occurrence in the case of portions of placental tissue retained after labour or abortion, and the clinical results are sufficiently familiar to require no notice in this place. When the entire ovum is retained putrefaction is extremely rare. The reason is that the retention cavity is an aseptic chamber, and unless organisms are introduced by operative interference, or make their way in from bowel adhesions or otherwise, the ovum undergoes non-putrefactive necrosis. Cases are, however, recorded where a fœtus has been discharged piecemeal from the uterus, after being retained for many months, or even for years, without mechanical interference. Putrefaction is much more common in the case of an extra-uterine than a uterine ovum, owing to the liability of the former to injury from rupture, etc.

The tissues of the placenta, though prone to certain forms of degeneration, are not subject to such varied or well-defined diseases as most of the adult organs of the body. Perhaps the explanation of this lies in the embryonic character of the tissues themselves, which is preserved throughout the whole duration of the existence of this organ. Fœtal tissues, for example, never show an active inflammatory reaction; they appear to perish under the influence of an irritant which would be insufficient to destroy adult tissues, but would induce in them an inflammatory reaction. The only inflammatory lesion the existence of which in the placenta has been clearly shown is peri- and end-arteritis, which occurs freely in the mature placenta; here, of course, the inflammatory process is of an inactive kind. Lesions formerly described as due to "placentitis" are now recognised as resulting from degenerative processes. The effect of placental lesions upon the life or development of the fœtus appears to depend more upon their extent than upon their nature. A considerable diminution in the total amount of healthy placental tissue appears to be required to influence the fœtus unfavourably. The analogy of pulmonary diseases is not inapt. It is well known that a considerable area of lung tissue may be destroyed or rendered functionless without much embarrassment of the respiratory process. And similarly an amount of placental tissue much less than that provided by nature appears to be quite sufficient to carry on the processes of fœtal nutrition and excretion.

ANOMALIES OF THE PLACENTA.—*Anomalies of Size and Shape.*—While subject to considerable variations within certain limits, the size of the placenta corresponds during the last three months of gestation to about one-fifth of the total area of the internal surface of the uterus. A marked increase in the area or thickness is usually due to œdema, or to some form of degeneration, and thus becomes a pathological condition, not an anomaly.

A few rare instances have, however, been recorded in which the placenta was equally disposed around the entire ovum, instead of being developed at one or other pole. This condition has received the name of *placenta membranacea.* It is, of course, due to persistence of the arrangement invariably found in the first two months of gestation in which the chorionic villi are equally developed all over that membrane. In some mammals (*e.g.* the cetacea) the diffused form of placenta is always met with, and its occasional occurrence in the human species is extremely interesting. A case has also been comparatively recently reported in which the placenta formed a ring around the ovum, indistinctly divided into three lobes. This corresponds to the zonary placenta of some carnivora. It is produced by an anomaly in the distribution of the changes which result in the disappearance of the extra-placental chorionic villi.

Instead of being a single organ, the placenta may be variously divided into lobes, the segments being continuous with one another through membrane over which the branches of the umbilical vessels pass. There may be two lobes (placenta bipartita), either equal or unequal, or three or more lobes may be present (placenta tripartita, p. multiloba). All medical men are familiar with the variety of this condition known as *placenta succenturiata*, in which one or more small outlying portions of placenta, usually circular in shape, are found connected by a bridge of membrane with the main portion of the organ, and are extremely liable to be left behind when the placenta is expelled from the uterus.

Anomalies in the insertion of the cord are also fairly common. Usually the attachment is in the centre of the placental organ; not infrequently it is markedly eccentric, sometimes even to the extent of being attached to the placental margin (battledore placenta). A rarer variety of insertion is that known as the *velamentous*, in which the cord is inserted into the membranes two or three inches or more outside the placental margin. The vessels bifurcate at the point of insertion, and their divisions run between the amnion and the chorion to the placenta, which they enter in the usual manner. The vessels running between the membranes are liable to injury during labour.

The placenta is usually developed equally around the point on the periphery of the ovum at which the allantois and the ventral stalk reach it. If for any reason the placenta is developed unequally around this spot, eccentric insertion of the cord results; if at a distance from this spot, a velamentous insertion results.

Diseases of the Placenta

Inflammation.—A subject which bulked largely in earlier accounts of the morbid conditions of the placenta was *placentitis.* The changes described were usually those already mentioned as senile or post-mortem changes, and their relation to an inflammatory process was a matter of pure speculation. As a matter of fact, we know nothing of inflammation of the fœtal placenta, apart from gonorrhœal or septic infection, as the direct result of inoculation of the gravid uterus. Infection of the ovum in this manner is, of course, incompatible with its further existence, and the dead tissues undergo rapid putrefaction. The gonococcus has been in two cases detected in early abortions attributable clinically to gonorrhœa, but little or no systematic work has been done at the bacteriology of this subject. It is possible that the condition known as "morbid adhesion of the placenta" is the result of an inflammatory affection of the decidua serotina, but we are not in possession of positive evidence upon the point. The fœtal elements are, in any case, not involved in the process. Certain fairly well-defined forms of inflammation affect the young decidual membrane (decidual endometritis), but an account of this will be found in another place. Fœtal endarteritis has already been referred to.

Hæmorrhage.—The conditions known to obstetricians as placenta prævia and accidental hæmorrhage (see pp. 70 and 77) are instances of hæmorrhage due to separation of the placenta from the uterine wall, and in both cases the bleeding occurs during labour or in the later months of pregnancy. With these conditions we are not here concerned. The subject is further limited by the exclusion of hæmorrhages occurring into the chorion before the formation of the placenta; these are dealt with in another place. We therefore exclude from consideration hæmorrhage into the early ovum, and hæmorrhage from separation of the adult placenta. Hæmorrhage into the substance of the placenta (placental apoplexy) occurs in two distinct forms:—

(*a*) Small interstitial hæmorrhages.
(*b*) Large effusions.

(*a*) *Small interstitial hæmorrhages* are not uncommonly found in the form of circumscribed areas of the cut surface of the placenta, which appear to the naked eye to be almost black, and are easily distinguished from the healthy placental tissue by the purplish colour and reticulated texture of the latter. Usually they lie nearer the maternal than the fœtal surface, but they do not show upon the former surface when the serotina is intact. There is no uniformity about their size and shape; the largest appear to involve an entire cotyledon; there may be many small ones scattered through an otherwise healthy placenta. Under the microscope the hæmorrhagic areas are seen to consist mainly of blood-clot in which are scattered a few atrophied or distorted villi; the villi are more numerous at the margins than in the centre of the hæmorrhage. It may be objected that such a condition as this is not hæmorrhage, because the blood is still contained in the intervillous spaces and has not escaped from its normal channels. But it differs from mere congestion or engorgement of vessels, inasmuch as the surrounding structures (villi) are disturbed, and in part destroyed, by the process. Except in a technical sense, it is interstitial hæmorrhage. These hæmorrhages do not affect the functional activity of the placenta to an extent sufficient to react unfavourably upon the fœtus. It is quite possible that they are produced during labour by the influence of the uterine contractions upon the maternal circulation through the placenta. A case has been recently reported by Dr. Blacker, in which an extensive hæmorrhage of this kind occurred in a very young placenta, from cardiac disease, without inducing abortion or causing the death of the fœtus.

(*b*) *Large effusions of blood* into the placenta are much rarer than the interstitial hæmorrhages just described. Such effusions are probably produced more rapidly, and therefore break up the placental tissue to a much greater extent than the interstitial ones. In consequence, irregular cavities containing blood-clot are formed in the substance of the placenta, limited in recent cases by compressed and broken villi, and in older cases by layers of fibrin forming a false cyst wall. In some of these cases the hæmorrhage is fœtal from rupture of a branch of the umbilical vein or artery in the placental tissue, and sometimes the cavity communicates with the circular sinus (maternal). After accumulating in the placental substance the blood may burst through the serotina, causing some separation from the uterine wall; such an occurrence might cause external hæmorrhage. The fœtus is born dead when hæmorrhages of this kind exist in the placenta. If abortion does not immediately follow its occurrence the effused blood undergoes the usual changes from clotting, absorption, or partial organisation and degeneration. The causes of large placental hæmorrhages are by no means fully known. In a case observed by the writer the mother suffered from albuminuria during pregnancy, and the portions of the placenta unaffected by the hæmorrhage showed extensive pathological infarction, as is so commonly the case in albuminuria. But the whole subject of placental hæmorrhage still requires a great deal of systematic work.

Œdema.—Œdema of the placenta usually results from disturbances of the fœtal circulation or changes in the fœtal blood, and is therefore associated with general œdema of the fœtus, and due to the same causes as this condition. Cases of maternal dropsy have also been recorded in which the placenta was œdematous: in these cases the cause would appear to be maternal; but more often placental œdema is due to a fœtal cause. Instances may be found of obstruction to the arterial return from the placenta by antenatal closure of the foramen ovale, or thrombosis of the umbilical and hypogastric vessels before birth, in which both the placenta and the fœtus were œdematous. The placenta of acardiac monsters is also frequently œdematous.

Within recent years several cases of fœtal and placental dropsy have been carefully recorded, in which there was present a marked excess of leucocytes in the fœtal blood; in one of these cases, recorded by Liefart, the mother suffered from albuminuria and dropsy, which rapidly cleared up after labour. Possibly in these cases the morbid condition of the fœtal blood was due to the increased toxicity of the maternal blood, which has been shown to exist in the albuminuria of pregnancy. Virchow and Franck have observed that in general dropsy of the fœtus of bovine animals the thoracic duct and mesenteric lymphatics are often absent, but this point does not appear to have been investigated in the human fœtus.

An œdematous placenta is larger and heavier than normal, and undergoes a great diminution in weight when incised and drained of fluid. The normal weight of the organ is 16 ounces; in the case reported by Liefart (*loc. cit.*) the œdematous placenta weighed 67 ounces. In colour it is pale, and in consistence unusually friable and soft. Microscopically the villi are found enormously increased in size and closely packed together, so that the size of the intervillous spaces is much reduced, and they therefore contain comparatively little blood. Many of the fœtal vessels are thickened or thrombosed, and the stroma of the villi is poor in cells and contains abundant fluid in its spaces. Frequently marked fatty degeneration of the chronic epithelium is also present.

Usually the fœtus dies *in utero*, although this event is not by any means of invariable occurrence. Œdema most seriously impairs the functional capacity of the placenta, but as it is never idiopathic we cannot tell precisely what effect it exerts upon the nutrition of the fœtus. The morbid conditions associated with it may be sufficient to destroy the fœtus.

Pathological Infarction.—It has already been stated that during the last two months of intra-uterine life certain changes referable to senility occur in the fœtal placenta, resulting in the formation of small solid bodies in the spongy placental substance termed "infarcts." Under conditions of health these are neither large enough nor numerous enough to interfere with the functional capacity of the placenta or the nutrition of the fœtus. Within the last decade it has been shown that changes similar in nature, but much more widespread and occurring much earlier in gestation, are found in association with a well-known disorder of pregnancy, viz. albuminuria. This condition has long been known to cause a heavy fœtal mortality, estimated on recent evidence at 54 per cent, and evidence has now been advanced that the changes in the placenta are the cause of the death of the fœtus.

In a marked example of pathological infarction a considerable proportion ($\frac{1}{3}$ to $\frac{1}{2}$) of the placenta is converted into a firm, yellowish, apparently bloodless tissue, which is seen under the microscope to consist of atrophied chorionic villi with large deposits of fibrin, both elements usually showing marked fatty degeneration. Hæmorrhages may be found in the non-infarcted portions of the placenta. In marked cases of albuminuria pregnancy seldom continues beyond the thirty-sixth week, and the earlier the onset of labour the more marked are the placental changes. As a rule the most extensive changes of all are found in the placentæ of fœtuses which have perished *in utero*, and have been borne in a state of maceration. The infarction appears to depend upon an obliterative endarteritis of the fœtal vessels. It has long been known that the fœtus of albuminuric mothers is smaller and lighter than the normal fœtus of the corresponding period of gestation; it is, in fact, under-developed, and possesses but low vitality

Degenerations.—The following forms of degeneration affect the placenta:—

1. Vesicular degeneration (hydatidiform mole).
2. Myxoma fibrosum.
3. Fatty and calcareous degeneration.
4. Cystic degeneration.

1. *Vesicular degeneration* is a form of myxomatous degeneration of the stroma of the chorionic villi which usually occurs at an early period before the differentiation of the placenta begins; it is therefore more commonly a disease of the chorion than of the placenta, and will be found fully described in that relation in another place. In rarer instances, however, it occurs at a later period, and is then found in the placenta. The disease has the main general characters as in the hydatidiform mole, but the whole placenta is seldom affected; usually one or two cotyledons degenerate, while the rest of the organ escapes.

2. *Myxoma fibrosum* is a form of myxomatous and fibroid degeneration of the chorionic villi which is usually described as a new growth, although it would be more accurately classed as a form of degeneration. It will be described under "Tumours of the Placenta," p. 20.

3. *Fatty and Calcareous Degeneration.*—Fatty degeneration is rarely found in the placenta except as the result of pre-existing lesions. The observations of Barnes and Druitt, which are still sometimes quoted in text-books as the first description of primary fatty degeneration, have been shown to be incorrect. A certain amount of fat is contained in the normal human placenta, being located in the plasmodial layer of the chorionic epithelium and in the superficial layers of the decidua. This may be easily distinguished from pathological deposits, as it occurs in minute non-confluent droplets and is very small in amount. A good deal of fat is also found in white infarcts, the older infarcts containing the larger deposits. Fatty degeneration is perhaps most commonly met with as a sequela of pathological infarction in albuminuria, and is probably the direct result of the extensive arterial obstruction of the fœtal vessels which occurs in that condition. It is also not uncommonly found in connection with placental œdema and in placentæ retained *in utero* after the death of the fœtus. There is no evidence of any well-defined relation between syphilis and fatty degeneration, as was so frequently stated in earlier papers on this subject.

In parts which have undergone fatty degeneration a deposit of lime salts is often found. In a ripe placenta numerous small thin calcareous plates are present upon the maternal surface; they occur in the serotina, and as a rule do not involve the villi. Instances are on record where almost the entire uterine face has been thus covered with a thin calcareous plate. Such deposits do not appear to affect the functional activity of the placenta.

4. *Cystic Degeneration.*—By this term is understood the formation of cysts by a process of degeneration. Cysts occur but rarely in the placenta, being occasionally observed upon the fœtal surface of an otherwise healthy organ. Here they occur as small multiple collections of clear yellowish fluid situated beneath the amnion. This membrane can be readily peeled off the cyst which appears to be in the substance of the sub-amniotic chorion or the basal plate of placental chorion from which the villi spring. Occasionally similar cysts occur in the amnion itself. They are produced by a process of myxomatous degeneration of the connective tissue, and possess no epithelial lining, their walls being formed of degenerating and compressed connective tissue. The placental connective tissue is all of embryonic type, and is very prone to this form of degeneration. These cysts never exceed the size of a pigeon's egg, and do not interfere in any way with the functional activity of the placenta.

Tuberculosis.—Tubercular disease of the placenta is probably rare; at anyrate the number of cases recorded in recent years is exceedingly small. It has been shown to occur, however, in women affected with chronic pulmonary phthisis, or with acute miliary tuberculosis. Cases occurring under both of these conditions have been recorded by Schmorl and Kockel, Lehmann, and Londe.

Placental tubercle possesses the same general characters as tubercle of other organs. The nodules are found in the substance of the cotyledons more often than upon the surface, and are more abundant in the marginal than in the central parts. They are usually firm and fibrous in texture, but sometimes caseating. Under the microscope they are seen to contain characteristic giant cells, and tubercle bacilli can be recognised by the usual differential staining reactions. Inoculation experiments upon rabbits and guinea-pigs show that the bacilli are active. Schmorl describes the tubercles as occupying two distinct positions in his cases; usually they were upon the surface of the villi, encroaching upon or obliterating the adjacent intervillous space. Sometimes, however, they were situated in the stroma of the villus, the surface epithelium covering it being intact.

In almost all the recorded cases the maternal disease was so advanced that the mother died either during labour or very soon afterwards. In the six cases recorded by Schmorl, and Kockel, and Lehmann, the fœtus died soon after birth, and a post-mortem examination was made. In only one case, however, was tubercle found in the fœtal organs, and in this case there were characteristic deposits found in the lungs, liver, spleen, and left kidney, and microscopically the tubercle bacillus was readily recognised. In all the other cases, not only could no tubercle be found in the body of the fœtus, but inoculation experiments were also attended by negative results. The blood from the tubercular placenta was, on the other hand, usually infective. From these facts it would appear that the fœtus is to a certain extent protected from infection from the maternal blood by the placenta, the organisms being detained there as in a filter. In only one of the recorded cases is it stated that the fœtus died *in utero* before the onset of labour.

The diagnosis of placental tubercle is impossible except by the microscope. It does not destroy the fœtus, and gives rise to no symptoms which can be recognised during life.

Tumours of the Placenta.—New growths are among the rarest diseases which occur in the placenta. A Norwegian writer, Alin, succeeded in collecting records of 23 cases from the literature of all countries, and 6 other cases have been since reported, making a total of 29 in all. As reported by the various writers, these tumours numbered, myxo-fibroma (myxoma fibrosum, of Virchow), 14; fibroma, 5; angioma, 5; fibromyoma, 2; sarcoma, 3.

Many of the earlier cases are, however, insufficiently reported, and the nature of the growth remains open to doubt. It will be noticed that all the above are varieties of connective tissue tumours; no new growth arising in epithelium appears to have ever been reported. The malignant uterine growth known as deciduoma malignum cannot be regarded as a tumour of the placenta, even if the current theory of its origin in fœtal epithelial cells be accepted. Tumours of the placenta do not exert such a markedly unfavourable influence upon the fœtus or the mother as might at first be supposed. Out of the 29 cases a living fœtus was born in 25; the remaining 4 were born dead; a fœtal mortality of 1 in 7 cannot be regarded as a high mortality for a serious placental lesion. Labour was not unfavourably influenced in any case. The frequency with which myxo-fibroma occurs in the placenta is very marked in comparison with the other new growths; it is the only one which need be described in detail.

Myxo-fibroma (myxoma fibrosum).—Although the commonest form of placental tumour it is a rare disease. It occurs as a firm, rounded swelling, usually in the substance of the placenta, and forming a protuberance upon both surfaces, or in the case of growths of smaller size, upon the maternal surface only. Less often the tumour forms a pedunculated mass attached to the maternal surface, and has a more or less definite branching arrangement. The fœtal surface of the tumour is covered with the amnion, which may be stripped off it, showing that the membrane is not involved in the tumour. Often there is a distinct fibrous capsule, and occasionally there are multiple growths. The microscopic characters of the growth are not uniform, and are described in very different terms by different writers. In the main it appears to consist of altered villi. The villi are enormously enlarged—upon this point there is practical unanimity—by increase of their stroma. The characters of the altered stroma appear to vary, but speaking generally, the change is one of myxomatous and fibrous new formation, the relative proportions of the myxomatous and fibrous tissues being variable. The chorionic epithelium does not alter, and is often retained upon the enlarged villi. Sometimes the vessels of the affected villi are much enlarged, forming the variety of the growth called *myxoma fibrosum telangiectodes.* The growth is of course benign in all cases, and the parts of the placenta not involved in it are healthy.

DISEASES OF THE MEMBRANES.—*Decidual Endometritis.*—This condition is a disease of the early ovum, affecting the decidua in all parts, and occurring at a period prior to the formation of the placenta. Two distinct forms are described, viz., the *glandular* and the *interstitial.* The *glandular* form corresponds to the common glandular form of endometritis in the non-gravid uterus, and probably results from conception occurring in a uterus whose endometrium was thus affected. The decidual membrane is of unusual thickness, and frequently presents small polypoid cysts upon its uterine surface, formed no doubt by cystic dilatation of the deeper portions of the uterine glands. The microscope does not disclose any actual inflammatory changes, the morbid condition being characterised mainly by glandular proliferation, with some increase of the normal inter-glandular stroma. The *interstitial* variety, on the other hand, is a true inflammatory change characterised by round cell infiltration of the whole membrane, congestion of vessels and interstitial hæmorrhages, with inconsiderable changes in the glands. Emanuel has shown that it may be caused by the gonococcus, and has demonstrated the presence of this organism in the inflamed membrane. Cholera and certain of the exanthemata are also said to cause acute hæmorrhagic endometritis in pregnancy, but further observations are required in this direction.

The symptoms associated with decidual endometritis are pain and hæmorrhage during the first three months of pregnancy, and a marked tendency to abortion. If the ovum survives that period atrophy of the decidua begins, and the danger abates. Diagnosis can only be established by microscopic examination of the membrane. It is possible that morbid adhesion of the placenta is a sequela of this condition.

Diseases of the Umbilical Cord.—The umbilical cord is less prone to disease than the placenta; the number of morbid conditions which are known to occur in it is very small indeed.

Such accidental anomalies as undue or diminished length and thickness, true and false knots, and excessive torsion, need only be mentioned; the latter condition is only found in the case of a dead fœtus, and is now usually believed to be a post-mortem occurrence. Syphilitic endarteritis and periphlebitis have been described in the umbilical arteries, sometimes to the extent of causing actual obliteration of the lumen. Degeneration cysts are sometimes met with of the same nature as those occurring in the placenta. A case of myxosarcoma of the cord has been described by Winckel.

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Intra-Uterine Diseases and Death of Fœtus

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Physiology.—The study of the intra-uterine diseases of the fœtus is a subject which has been systematised only within recent years. The pathology of ante-natal life may be divided into three parts: the pathology of the germ, of the embryo, and of the fœtus; and it is with the last-named portion that we have here to do. It has more in common with the pathology of post-natal life than have the pathology of the embyro and that of the germ; for it has mainly to do with diseases while these others have to do with monstrosities and malformations and predispositions. Nevertheless the diseases from which the fœtus suffers show many peculiarities, and are not always recognisable as the same maladies as those which are met with in adult life or even in childhood. These peculiarities are due to certain circumstances, such as the intra-uterine environment, to which attention will be drawn immediately; in the meantime it is necessary to have some knowledge of the physiology of fœtal life.

The *physiology of the fœtus* throws much light upon its pathology. Its chief feature is its parasitism. The fœtus spends the whole of its existence, about seven and a half months, in the interior of the uterus: it is immediately surrounded by the liquor amnii, which, serving as a natural water-cushion, protects it from sudden shocks and jars; the uterine walls, by their growth and distensibility, allow increase in size and freedom of movement to the fœtus, while they shield it from harm, and maintain by their vascularity that constant temperature so needful for healthy development; and, external to the uterus, are the partly osseous, partly muscular pelvic and abdominal walls, which serve still further to secure the safety of the tender organism. In its protected position the fœtus makes little call upon several of its organs; its lungs are absolutely quiescent, its stomach, intestine, skin, kidneys, and lymphatic glands are nearly so. The heart and liver, however, are active; the thymus, thyroid, supra-renal glands, and sympathetic system play a considerable part in the physiology of intra-uterine life; and the brain and spinal cord are capable of replying to all the demands made upon them. The most important of the fœtal organs, however, is the placenta, although the fœtus is only part-possessor in it, and it lies outside the fœtal body. It is the dominating influence in fœtal life, and is absolutely essential to the unborn infant; in fact, fœtal vitality, although not structural integrity, may be maintained by the help of the placenta alone. The study of monstrosities has proved that almost all the organs may be absent, or so malformed as to be useless; if only the placenta be healthy and active the fœtus lives on until its expulsion from the uterus deprives it of the assistance of the placenta, and so brings about its death. Just as post-natal life is ushered in by a transition period, the neo-natal, during which the organism is being readjusted to its new environment, so fœtal life begins with a period which may be called neo-fœtal, in which the circumstances which prevailed during embryonic life are being replaced by those which characterise fœtal existence; the outstanding phenomenon of this transition time is the establishment of the placental connection. Embryonic life has as its most striking feature evolution or development; it is a period of planning, of arranging; and in it the apparently similar cells of the early embryo are grouped together to form the various organs of the fœtus. The chief result of physiological activity on the part of the fœtus, on the other hand, is rapid growth along the lines which have been already laid down. At the same time the whole organism does not pass at the same moment out of the embryonic into the fœtal period; there is a projection of the embryonic into the fœtal in the physiology of ante-natal life.

The *pathology of the fœtus* is characterised by diseases as distinguished from embryonic pathology, which has malformations and monstrosities as its peculiar possession. Further, it is probable that with certain inconsiderable exceptions the fœtus is liable to the same diseases as is the adult or child. In a broad sense it may be said that the pathology of the fœtus is coextensive with that of the adult. The fœtus enjoys a partial immunity from the attacks of parasites which produce skin diseases in extra-uterine life, and it is to some extent protected from external violence by its environment; with these exceptions, it has the same wide pathological possibilities as had the adult or child. It is true that elaborate details concerning the mode of onset, symptoms, and progress of fœtal maladies are not to be found in text-books of medicine; but this is due to the fact that these diseases are during their evolution hidden from the eye in the darkness of the womb, and only come under the observation of the medical man when the expulsion of the fœtus from the uterus happens to coincide with the stage of full development of the disease, and occurs before the death of the fœtus has taken place. There are other reasons, also, of a more commonplace kind which help to explain how it is that more is not known about these intra-uterine maladies: these are the low estimate which has been placed upon the value of fœtal life, the absence of exact knowledge regarding intra-uterine physiology, and the invasion of the subject by such unscientific imaginings as those connected with maternal impressions. The peculiarities of fœtal diseases also mask them and prevent their identification with the diseases of the adult.

The *classification* of fœtal diseases and morbid states may be founded upon their pathology, their distribution, or upon their etiology; but no satisfactory scheme has been elaborated, nor is one possible until our knowledge of the whole subject is much enlarged. In the meantime it is convenient to divide the morbid states from which the fœtus may suffer into (1) idiopathic diseases, (2) transmitted diseases, (3) traumatic morbid states, (4) transmitted toxicological states, and (5) pathological conditions of the fœtal annexa, the placenta, membranes, and cord. A special department has to do with fœtal death and its pathology.

The *causes of the peculiarities of fœtal diseases* are to be looked for in the influence of the intra-uterine environment, in the placental factor, and in the embryonic factor. A few words must be said in explanation of these various modifying agencies. The special conditions which characterise intra-uterine existence are responsible for several of the peculiarities which are impressed upon the maladies of this period of life. Traumatism, for instance, as it is understood in post-natal life, is a rare occurrence in fœtal life. So well is the unborn infant protected that it is very uncommon for it to be the subject of fractures, dislocations, and wounds apart from those received during the act of birth. Of course now and again such injuries are met with as the result of gross maternal traumatism, such as abdominal compression and laceration; but they are rare, and the fractures and so-called intra-uterine amputations which are recorded have probably another origin (from amniotic pressure) to which reference will be made in the proper place. The modifying effect of environment is seen also in the characters which some of the exanthemata take on when they occur *in utero.* Thus, in fœtal small-pox the eruption on the skin resembles that which occurs on the mucous surfaces in later life, a fact which is probably due to the influence which the circumambient liquor amnii exerts; there is rarely a noteworthy formation of crusts, and the resulting cicatrices are very slightly marked; and the pustules do not appear to affect the face to the same extent as they do in the small-pox of later life, probably because the face is not less protected from the light than are the other regions of the body. Possibly the intra-uterine surroundings have also brought it about that erysipelas, at any rate in its cutaneous manifestations, is very rare in the fœtus. The enormous thickening of the epidermis in fœtal ichthyosis has been ascribed to the comparative absence of friction *in utero.* The peculiarities of the changes which follow fœtal death must certainly be largely due to the environment of asepsis with which the unborn infant is in normal circumstances surrounded. The placenta, which plays so important a part in the physiology of the fœtus, has an equally important effect upon its pathological developments. Thus, the presence of the placenta makes it possible for the fœtus to be diseased in structure to a very advanced degree without the suspension of its vitality. An enormous amount of morbid change may be present without the cutting short of intra-uterine life. So long, for instance, as the fœtal malady attacks organs whose functions are performed in whole or even in part by the placenta, the induced morbidity is only potential. The lungs may be solid from pneumonia and yet no inconvenience be caused to the fœtus *quâ* the state of its lungs so long as the placental economy is maintained. This potential morbidity becomes real at birth. The potential mortality of the fœtus is another effect of the placental predominance. An amount of structural change quite incompatible with extra-uterine existence may be present *in utero* without causing fœtal death. A fœtus with general dropsy may come to the full term with its peritoneal, pleural, and pericardial cavities loaded with fluid, and with advanced changes in its internal organs; it may even show signs of life at birth; yet it invariably dies in a few minutes or at most hours thereafter. The potential mortality became real at birth. It is in virtue of this effect of the placenta that grossly malformed embryos are carried through the fœtal period of intra-uterine life and brought to the light; perhaps the mother is thus saved from the dangers of intra-uterine death or premature delivery. Again, the placenta acts sometimes, at least, as a barrier preventing the access of poisons and toxines circulating in the maternal system to the fœtal economy. It has been shown that in the lower animals, at any rate, the placenta has a real affinity for some toxic bodies, and by storing them up in its substance prevents them passing to the fœtus. In this respect it resembles the action of the liver in the adult, being an accumulator of poisons. Of course it does not necessarily prevent their passage, although it may store them up. With regard to the effect of the placenta in keeping back microbes from the fœtus there is still much uncertainty. The idea that it acts always as a filter must be abandoned; that it acts often as a prophylactic barrier is also open to grave doubt. Bacteriological researches have shown that through it can pass the bacilli of anthrax, of fowl cholera, and of typhoid fever, the pneumococcus, the streptococcus, the spirillum Obermeyeri, the bacillus of glanders, the pathogenic organism of hydrophobia, and perhaps the hæmatozoon of malaria. So we have now to look at the opposite side of the question, viz. the placenta as a means of access of germs and toxines to the fœtus. It is certainly the chief if not the only avenue of entrance to the fœtal economy; for it cannot be accepted that substances often pass by the membranes into the liquor amnii, and are then swallowed and so reach the interior of the unborn infant. It would seem also that it is not necessary for the placenta to be macroscopically diseased, as by hæmorrhage into its substance, in order that the organisms may pass; in fact, in some cases in which the germs have passed, the placental tissue does not appear to have been even microscopically affected. It cannot be said that the conditions which increase or diminish placental permeability are yet well known; but one or two important conclusions have been arrived at. It is, for instance, apparent from the study of the comparative anatomy of the placenta that its permeability must vary in different species with the thickness of tissue intervening between the maternal and fœtal circulations; in this respect it would appear, from the extensive researches of Duval, that the human placenta occupies an intermediate position between that of the rodents and that of the ruminants. Again, there is reason to believe that placental permeability varies with the epoch of pregnancy reached. It would seem also, although the evidence rests on experiments on animals and not on observations on the human subject, that the presence in the blood of toxines, as tuberculine, or of alcohol, increased the permeability of the placenta, while the previous inoculation of the system with an antiseptic, such as corrosive sublimate, made it more difficult for the germs to pass. The fact that it is through the placenta that infection reaches the fœtus has an important bearing upon the position of primary lesions in the fœtus. The germs and toxines arrive at the body in the blood, passing first through the placenta and umbilical vein, then either through the liver or ductus venosus, then through the heart, and so to the whole circulation. It is no matter for wonder, therefore, that the primary pathological changes are commonly found in the liver or heart, or placenta itself. Congenital tuberculosis is not often met with, but when it has been demonstrated it has been noted that the lesions were inconsiderable in the lungs and very extensive in the liver and spleen. Again, erysipelas in the mother has been found associated with streptococcic endocarditis in the fœtus, and not with erysipelatous inflammation of the fœtal skin. The placenta has been already referred to as the most important organ of the fœtal economy; for this very reason morbid changes in it are very immediately prejudicial to the fœtus. The healthy placenta may enable a diseased fœtus long to survive, but when it is itself the seat of disease it is very often the cause of fœtal death or of premature delivery. In order, therefore, to arrive at the cause of intra-uterine death it is very important to have the placenta for examination. While the placenta and the intra-uterine environment serve to account for some of the peculiarities of fœtal maladies they leave unexplained not a few. Many of these are due to the projection into fœtal pathology of the results of embryonic pathology. There is good reason for believing that malformations and monstrosities are the product of morbid agencies acting on the organism during the embryonic period, and the fœtus may therefore come into its epoch of intra-uterine existence with pathological states in it which are really embryonic. These must necessarily modify the morbid conditions which are superposed during the fœtal period, and fœtal diseases are affected in their manifestations by pre-existing malformations. Further, it is more than probable that the malformations themselves are altered in some respects by the diseases which supervene. It is, therefore, not to be wondered at that fœtal maladies have certain peculiarities which serve to distinguish them from the diseases of post-natal life.

The *diagnosis* of fœtal diseases while the fœtus affected by them is still *in utero* is an exceedingly difficult matter; even the Röntgen rays have not as yet done much to pierce the obscurity which surrounds fœtal morbid processes, for the ossification of the unborn infant is incomplete, and the mother's pelvis throws a dark shadow. Some little progress has, however, been made in this exceedingly difficult field of clinical investigation. Since the infant is in close relation to the chemical and vital processes going on in the body of its mother, a full consideration of all these processes, as they show themselves in the general maternal health, cannot fail to throw some light upon the general fœtal health. The better the state of health of both parents the more likely it will be that the progeny will pass through intra-uterine life without illnesses. It is necessary, therefore, in the first place, to take into account the past history of the parents; especially is it important to investigate the past obstetrical history of the mother, for fœtal diseases often show a curious tendency to repeat themselves in consecutive pregnancies. This repeating tendency has been noted in general fœtal dropsy and in fœtal ichthyosis, and it is, of course, evident in fœtal syphilis. It may be mentioned in passing that the same phenomenon has been remarked in teratology; women, who may in consequence be called monstriparæ, having been known to give birth to several monstrosities in succession. The influence of the father sometimes makes itself felt, for cases are on record in which a woman has had healthy children by a first husband, and dropsical or ichthyotic ones by a second, her own health having continued apparently unaltered. It is necessary also to inquire into the symptomatology of pregnancy, for abnormal intra-uterine conditions sometimes give evidence of their presence by alterations in the normal manifestations of gestation. Unusually active or unusually inactive fœtal movements may occur in fœtal disease, and I have the notes of a case of fœtal singultus diagnosed by the peculiarity of the movements made by the infant still *in utero.* All matters, such as the exposure of the mother to infection or to traumatism during pregnancy, ought to be noted. The fact that she herself is suffering from malaria, small-pox, measles, scarlet fever, typhoid, and the like, is strong presumptive evidence that her infant *in utero* is similarly affected. In cases of general tuberculosis of an advanced type, it is now known to be possible for the fœtus also to be tubercular. The actual examination of the mother, and especially of her abdomen, may give some hint as to the state of the unborn infant. Thus the presence of hydramnios has been found to be very constantly associated with an intra-uterine pathological state, either of the nature of a disease or a monstrosity, and hydramnios can generally be diagnosed by careful examination. Again, it has been noted that occasionally the fœtal heart sounds have been impure, and the diagnosis of fœtal heart disease or malformation has on several occasions been made and confirmed after the birth of the child. During labour it is sometimes possible to diagnose a fœtal disease, and even then the diagnosis is not without value, for it enables the medical man to forewarn the interested parties of the state of matters, and so save himself in some measure from the reproach attaching to the unexpected advent of a diseased infant. The diagnosis of intra-uterine death will be considered later.

Intra-uterine therapeutics is a subject which has as yet made little progress, and it can hardly be expected to make much until intra-uterine diagnosis has been perfected. Nevertheless, in some few directions the outlook is in some degree hopeful. The study of fœtal pathology has shown that it is dangerous for the pregnant woman to expose herself to the infection of the exanthemata, even if she herself have suffered previously from the special fever in question, for her acquired immunity does not extend to her unborn infant. In the presence of an epidemic of variola, the vaccination of the pregnant woman becomes a rightful precaution, not so much for her own sake as for that of her fœtus, for it has been shown that sometimes the latter is thus rendered immune to subsequent vaccination, and therefore probably to small-pox. In the same way quinine may be given to the pregnant woman surrounded with the malarial poison. The giving of mercury to the syphilitic mother for her own sake, but also for that of her unborn infant, need not be specially referred to, for it is an everyday matter in practice; but it is well to remember that when the father alone is affected, it is still right to administer mercury to the mother when pregnant for the purpose of directly acting on the child. Chlorate of potash is a drug which has a good effect upon certain abnormal intra-uterine states, such as the tendency to habitual abortion or premature labour; possibly it proves beneficial by its action on the placenta; it may be combined with iron with advantage. There are certain cases in which, on the other hand, it may be good treatment to induce labour before the full time, in order to save the infant from a malady which has been shown to come on about the last month of intra-uterine life, and the same course has been taken when a woman has on previous occasions given birth to infants which die in labour simply on account of their post-mature development.

Special Diseases of the Fœtus

The individual diseases of the fœtus cannot all be considered in this article, for that would entail the writing of a system of antenatal medicine; it will suffice if the maladies whose pathology differs most markedly from that of post-natal life be dealt with. The first that call for description are the idiopathic diseases of the skin.

Skin Affections.—*Fœtal ichthyosis* (*major degree*) is one of the most deforming of all the congenital skin affections. It is histologically a hyperkeratosis, and is characterised by the existence all over the body of horny epidermic plates, separated from each other by narrow fissures or deep and broad grooves; this gives to the infant the appearance which has earned for him the name of "harlequin fœtus." The mouth, eyes, and anus show ectropion, and the nose, ears, and limbs are more or less stunted in their growth from the compression exercised upon them by the thickened epidermis. The disease has shown family prevalence, that is to say, several infants of the same parents have been affected with it. It is not compatible with extra-uterine life, for in all the recorded cases death has followed birth within a few hours, or at most days. Lactation is always much interfered with by the state of the mouth. The horny layer of the epidermis is enormously thickened; this is the most characteristic lesion, and justifies the name ichthyosis, although in its adult form ichthyosis never approaches in severity to the fœtal.

Fœtal ichthyosis (*minor degree*) is characterised by the birth of an infant which appears as if it were coated all over with a layer of collodion. In a short time desquamation begins, and may go on more or less continuously for years. There is not usually much ectropion of the eyes and mouth, but cases have been reported showing the intermediate degrees between this, the benign, and the more grave type of fœtal ichthyosis which has been described above. It is not incompatible with a prolonged extra-uterine existence, and is capable of showing improvement under suitable treatment by warm alkaline baths and inunction with lanoline or glycerine.

Ichthyosis herpetiformis is characterised by the presence of papillomatous growths, distributed along the line of one or more of the cutaneous nerves, usually limited very exactly to one side of the body, and more or less pigmented. To this condition many names have been given, such as nerve-nævus, nævus neuroticus unius lateris, ichthyosis linearis neuropathica, and papilloma neuroticum; and it may be regarded as a localised form of congenital ichthyosis hystrix. It has been ascribed to fœtal herpes zoster. Division of the nerve supplying the affected area has been followed by cure.

Tylosis palmæ et plantæ is another form of hyperkeratosis, but it is limited in distribution to the palms of the hands and soles of the feet. It is very markedly hereditary. The lesion exists at birth, but only becomes evident when pressure on the parts becomes considerable. It has been also called ichthyosis palmaris et plantaris and keratoma plantare et palmare. Improvement may be obtained by painting the surface with a solution of salicylic acid in ether (5 per cent).

Fœtal keratolysis, or desquamation of the cuticle, is a normal phenomenon at the end of the first week of life, but it is exceptional to find it in the infant at the moment of birth. When it is met with in the fœtus it may signify fœtal measles, scarlatina, erysipelas, syphilis, anasarca, or simply post-maturity of the infant. Antenatal desquamation of the cuticle has by some been regarded as a certain sign of fœtal death, but it is undoubtedly found occasionally in the living infant.

Congenital hypertrichosis, or abnormal hairyness, may be general or local. In the former there is a persistence of the general lanugo-covering of middle fœtal life, and individuals thus affected are known as "hairy men," "missing links," and "hommes-chiens." There is sometimes defective development of the teeth. Localised hirsuties has its commonest form in the well-known *hairy nævus or mole.* It occurs on the face, back, or limbs, and may be associated with defects of the skeleton, such as spina bifida occulta and encephalocele. It is often ascribed to the so-called maternal impressions. The condition is of importance only on account of the deformity which it causes, and successful treatment by means of electricity or the Röntgen Rays may be obtained.

Congenital alopecia, or *hypotrichosis* may also be general or local; the former is commonly hereditary, and the latter is due to causes which are not at all well known, but which have sometimes been thought to include the antenatal spontaneous cure of a vascular nævus. Dental defects may be associated.

Pigmentary anomalies of the skin are sometimes met with at birth. Among these chromatoses must be reckoned the well-known *nævus pigmentosus* and the rare general *melanoderma,* in both of which there is an excess of pigment in the cutaneous tissues. The pigment may, on the other hand, be *absent* either in restricted areas of the body, as in the white streaks (sometimes unilateral) seen sometimes in dark-skinned peoples, or as a general affection in albinism.

Congenital pemphigus generally points to syphilis, but may sometimes be due apparently to a prenatal abnormal tendency to the formation of bullæ quite apart from the infection with syphilis. During birth the bullæ are commonly ruptured and the epidermis removed, producing the appearance of bare areas.

Congenital absence of the skin and *congenital ulcers* have quite a different mode of origin. They probably occur when there have been adhesions between the amnion and the fœtal skin (sometimes of a tubular nature), and these being torn through in the act of parturition, areas of denuded skin are left to mark the site of the amniotic union. They are of some medico-legal importance, as they may simulate the results of traumatism.

Fœtal Bone Diseases are very difficult to reduce to the terminology of adult osseous lesions, for the reason that before birth the skeleton is not yet fully developed. This fact in part accounts for the multiplicity of names which have been given to the fœtal maladies of bone, such as chondrodystrophia, periosteal aplasia, fœtal rickets, achondroplasia, and osteopsathyrosis. Until their pathology has been more fully investigated, they may all be included under the one name of *osteogenesis imperfecta.* In some cases there has been found to be a defect in the endochondral ossification alone, in others in the periosteal alone; in yet other cases the anomaly consists, not in defect, but in excess of formation of one part of the bones, and hypertrophy of the cartilage with absence of true bone formation has been observed. The connection of these maladies with rickets is problematical; at the same time it must not be forgotten that true rickets is occasionally present at birth. The clinical manifestations of osteogenesis imperfecta consist in friability of the bones, showing itself in the occurrence of fractures, which sometimes are very numerous, and which specially affect the long bones; in stunting in the growth of the bones of the limbs, sometimes masked by excessive proliferation of the cartilage of the epiphyses; and in malformations of the cranial bones, such as the premature ossification and consequent shortening of the bones of the basis cranii (formation of the os tribasilare). The malady of the bones is not always incompatible with extra-uterine life, as is shown by the existence of adult achondroplasiacs. Cases have even occurred in which an achondroplasiac mother has given birth to an infant suffering from the same affection of the skeleton as the parent. Charrin and Gley have succeeded in experimentally producing lesions of the fœtal skeleton resembling rickets in rabbits by submitting the parent animals to the influence of the toxines of the bacilli of diphtheria, tubercle, and blue pus. In the human subject it must be confessed that sometimes the parents of infants born with fœtal bone disease have been apparently perfectly healthy. General fœtal dropsy and so-called fœtal rickets have been associated in the same case more than once.[1]

Diseases of the Subcutaneous Tissue are not uncommon in the fœtus, and their characters are somewhat modified by the circumstance that the structures affected are in an incompletely developed state. The most important is *general fœtal dropsy or anasarca.* It is probably to be regarded rather as a symptom of various fœtal morbid states than as a distinct pathological entity. It is characterised by the existence of general anasarca, and by the presence of fluid in the peritoneal, pleural, and pericardial sacs; there is usually œdema of the placenta also. The dropsy may be so marked as to give a monstrous appearance to the fœtus and to obstruct delivery. In its advanced form the disease is quite incompatible with extra-uterine life. Family prevalence has been noted. The mother is not uncommonly dropsical also, and she may be the subject of cardiac, renal, or hepatic disease; hydramnios is an almost constant concomitant. It would seem that in some cases a purely fœtal cause of the dropsy is in existence, such as premature closure of the foramen ovale, absence of the thoracic duct, fœtal leukæmia, and cystic degeneration of the kidneys; but in other instances a maternal cause has to be looked for, such as anæmia, nephritis, or malaria. Some observers have regarded dropsy of the placenta as the starting-point of the whole morbid process. It is evident, however, that the dropsy is only a symptom, and may be due to a number of pathogenic circumstances. In its most deforming degree general dropsy is met with in the twin fœtus, especially in the allantoido-angiopagous twin or placental parasite. No treatment has yet been successful in preventing or in curing the malady, although chlorate of potash and iron in one case seemed to prevent the occurrence of premature labour, which is so often the termination of a gestation in which the fœtus is dropsical.

Congenital cystic elephantiasis is a malady which in some particulars resembles general fœtal dropsy. In it, however, the subcutaneous tissue contains numerous cysts containing clear serous or curd-like matter, and the resulting deformity is greater. It may be generalised, but more commonly it is widespread without being quite universal in distribution; in other cases it is restricted to a special region of the body, such as the head and neck. It consists in dilatation, or in dilatation and occlusion of the lymphatic vessels and spaces; and the dropsy which results is generally gelatinous in its character—hence the name hydrops anasarca gelatinosa, sometimes given to it. Premature birth is the usual clinical result of this disease. The mother may show albuminuria and hydramnios, but the relation of these conditions and the fœtal state is not clear.

The name *congenital elephantiasis* is usually given, not to the cystic form which has just been described, but rather to the fibrous or telangiectatic or neuromatous varieties. In these there is a more or less localised thickening of the subcutaneous tissue, with nævus-like vascularity of the part, and sometimes with a distribution specially following certain nerves. The malady is quite compatible with extra-uterine life, and in some instances has been cured by elastic pressure. In some instances, as in the case recently reported by Mainzer (*Deutsche med. Wochnschr.* xxv. 436, 1899), the resemblance to elephantiasis Arabum of the adult is very close, and some have held that it is really the congenital form of that disease. A case has been reported in which a woman during pregnancy suffered on several occasions from lymphangitis; her infant at birth showed enlargement of one leg, and blood taken from the leg revealed groups and chains of the streptococci of Fehleisen; the conclusion drawn was that during the maternal lymphangitic attacks streptococci passed through the placenta into the fœtal circulation. This malady is associated in some way with the condition of unilateral hypertrophy which is occasionally met with, and in which the distribution of the enlargement is exactly limited by the middle line of the body.

Atrophic conditions of the *subcutaneous tissue* are sometimes found as congenital states. There may be a total absence of the subcutaneous fat, and this anomaly may persist till adult life is reached, when the individual affected is described as a "living skeleton." A condition which is probably closely allied is *cutis laxa*, or *dermatolysis* (without tumour formations). The so-called "elastic-skinned men" exhibited at fairs and shows are instances of this curious condition of the subcutaneous tissue which microscopic examination has shown to be atrophy of the connective tissue bundles of the skin with a transformation of the firm tissue of the dermis into an unformed myxoma-like structure.

Fœtal ascites and peritonitis often co-exist in the fœtus; in fact ascites is rarely due to obstruction of the portal circulation in antenatal life, for the reason that the portal circulation is rudimentary then, and it thus happens that it is most commonly caused by peritonitis. Sometimes the abdominal distension thus produced is so great as to impede and even to prevent the birth of the infant altogether; as much as five or six litres of fluid have been found in the abdominal cavity. Usually the child is stillborn or has to be killed during labour to diminish its bulk, but there are cases on record in which puncture of the abdomen has been followed by recovery. Hydramnios is not uncommonly associated with peritonitic ascites, and the association with malformations of the intestines and genito-urinary organs is also noteworthy. Fœtal peritonitis is not always accompanied with effusion, and a case has been reported in which there were traces of at least two attacks of dry peritonitis in the same fœtus. The cause of the peritoneal inflammation is seldom clear; in some cases it has been ascribed to syphilis, but in others there is absence of all signs pointing to this cause. The writer has met with an instance in which the mother had been subject to the infection of measles during the last weeks of her pregnancy, and the fœtus had peritonitis. Distension of the urinary bladder is sometimes associated with peritonitis; there may then be either hydramnios or oligo-hydramnios.

Fœtal endocarditis is of importance as the cause of morbus cœruleus in infancy and childhood. It must, however, be remembered that it is not certain that all cardiac anomalies are due to inflammation affecting the heart; some malformations arise directly as such in the embryonic period of antenatal life. The origin of fœtal endocarditis has been a subject about which doubt has existed; but it has recently been shown that it may originate from the passage of germs from the mother to the fœtus through the placenta. In a case of maternal erysipelas reported by Bidone, the fœtus was found to be the subject of streptococcic endocarditis, and it is probable that the streptococci found their way directly to the heart through the umbilical vein and ductus venosus. In the same way, in a case of fœtal tuberculosis it was evident that bacilli had made their entrance into the heart and had set up tubercular endocarditis.

The TRANSMITTED DISEASES OF THE FŒTUS form an increasingly large group, and some maladies which were formerly regarded as idiopathic are now coming to be regarded as transmitted. Examples of this transference are found in endocarditis and elephantiasis, which have just been described. In addition to these there are syphilis, the exanthemata, malaria, sepsis, tubercle, and possibly rheumatism. In an earlier part of this article the question of the mode of transmission of diseases from mother to fœtus was considered, and reference was also made to some of the peculiarities of the exanthemata as developed antenatally; these matters need not be returned to here.

Fœtal syphilis may be due to infection from a syphilitic mother through the placenta; apparently it may also be the result of sperm infection, without the intervention of the mother. A common result of fœtal syphilis is premature labour, and the pregnancy thus terminated may have been complicated with hydramnios. The infant may be dead at birth, and then shows the appearances of intra-uterine post-mortem maceration; or it may be born alive without any sign such as is usually regarded as syphilitic, but with congenital weakness, which usually proves fatal in a few days or weeks; or, again, it may be born with the bullæ of pemphigus, or the desquamation of ichthyosis, or with internal pathological changes, especially of the liver and bones, which are commonly regarded as syphilitic; or, yet again, it may show at birth malformations of various kinds, and may be even the subject of a monstrous development, circumstances which are now coming to be looked upon as the stigmata of embryonic syphilis. The placenta is often diseased, but it is difficult to be certain whether a typical syphilitic placental lesion exists; the afterbirth is often large, friable, anæmic, and shows on section fibrous patches, along with areas which have a fatty appearance. The umbilical cord is often thicker than normal. The protean character of the phenomena of adult syphilis is amply foreshadowed in fœtal syphilis. The treatment of fœtal syphilis may be commenced before birth, for if the mother or the father be syphilitic it has been shown to be advisable to administer mercury to the mother during the whole term of her pregnancy; even if the mother have apparently escaped the infection the same treatment is to be pursued for the sake of the fœtus, which may be syphilitic in virtue of infection conveyed direct to it through the spermatozoa of the syphilitic father.

Various *infectious fevers* may affect the fœtus *in utero*, and cases are on record of fœtal small-pox, measles, scarlet fever, varicella, typhoid fever, erysipelas, and influenza. In most of the reported cases the mother has been also a sufferer from the fever in question, but it does not appear to be necessary that she must always be so, for a mother rendered immune to small-pox by a previous attack or by vaccination may escape infection, while her unborn infant takes the malady and is expelled in time with the eruption or the cicatrices of variola upon him. The infection is probably always conveyed through the placenta, and in such a fever as typhoid, where the micro-organism is known and can be recognised, bacteriological investigations make plain the avenue of invasion of the bacilli. It is true that fœtal typhoid differs in certain details, such as the rarity of the intestinal lesions typical of the adult form of the malady, but this is explicable on the general principles which govern intra-uterine infection. It has been recently shown that the blood serum of the fœtus of a woman suffering from typhoid gives the Widal typhoid reaction quite distinctly. There is some evidence to prove that infectious fevers in the fœtus may have effects which project themselves beyond the birth of the infant far into post-natal life; it is possible, for instance, that some of the so-called obstetric paralyses may have such an origin. This supposition is supported by an observation made by Osler, in which a pregnant woman suffering from typhoid fever died without the supervention of labour pains, and in the fœtus, removed from her uterus post-mortem, a well-marked hæmorrhage was discovered in the centrum ovale of the cerebrum. The blood effusion may have been due to the maternal typhoid; at the same time it may also have been syphilitic, for the woman was the subject of lues; but it certainly was not caused by compression of the fœtal head, for there had not been even the commencement of labour at the time the woman died. An interesting fact has been brought out with regard to fœtal measles, and probably the same is true of other fœtal fevers, to wit, that the infection of the fœtus and the mother would appear to be simultaneous, for the lesions in the fœtus, when it is expelled from the uterus, show the same stage of the disease as those in the mother; further, when intra-uterine death has occurred it would seem that at the moment of death the fever in the fœtus had reached the same stage as in the mother. The number of observed cases of fœtal fevers is as yet small, a circumstance due in no small degree to the difficulty of diagnosis, for it must be remembered that the physiological erythema and desquamation of the cuticle of the skin of the new-born infant are apt to prevent the recognition of fevers having these very cutaneous alterations as their leading features. At the same time, a very considerable literature has grown up around fœtal small-pox; in fact, it would seem as if all the possibilities with regard to this malady had been recorded, even to the extent that twins have been born, one of which was the subject of variola, while the other was apparently quite free from the infection. It may be also that, as in syphilis, so in the exanthemata, the incidence of the fever in the mother may determine in the fœtus, not the fever itself, but general changes in nutrition leading to stunting in growth, or even to actual malformations; possibly, also, as has been shown in maternal erysipelas, the fœtus may suffer, not from the cutaneous manifestations of erysipelas, but from septic poisoning. In relation to fœtal sepsis it must not be forgotten that sometimes the fœtus has become infected from the vaginal secretions of the mother, either before labour, through premature rupture of the membranes; or intra-natally, during the progress of the body through the birth-canal.

Fœtal malaria is an occurrence the possibility of which may now be looked upon as proven. Women suffering from intermittent fever have given birth to infants with hypertrophy of the spleen, and showing in the blood the hæmatozoon of malaria; further, during gestation it has been recognised that the incidence of a maternal ague fit has been accompanied by active fœtal movements which could only be explained on the supposition that the unborn infant also was the subject of a rigor. Felkin has reported a curious case in which a woman, apparently quite free from malaria, gave birth to an infant with malaria, and showing the ague splenic enlargement; the father was seriously ill with malaria, and the supposition was that the fœtus had been directly infected by the semen. In cases of malaria in pregnancy the fear of causing premature labour or abortion by the administration of quinine has been probably much exaggerated; it is well to give the drug, not only for the sake of the mother, but also on behalf of the unborn infant.

Fœtal tuberculosis is a malady the existence of which has been doubted; but of late years a number of cases have been reported in which the conditions found were such as to leave no longer any reasonable doubt about the occasional occurrence of truly tubercular lesions in utero. In some of the cases actual tubercular lesions were discovered in the fœtus; in others, although there were no gross lesions, yet the tubercle bacillus was detected in the fœtal organs and inoculations of animals with pieces of the fœtal organs, and with blood from the umbilical vein set up in these animals, undoubtedly tubercular processes. An excellent instance of fœtal tuberculosis, with lesions, was recently reported by Auché and Chambrelent (*Arch. de méd. expér. et d'anat. path.* xi. 521, 1899). It was that of a prematurely born, but living female infant, the product of a tubercular woman who died three days after her confinement. At the autopsy it was found that she had been the subject of advanced phthisis and of tubercular disease of the liver, spleen, intestines, mesenteric glands, and kidneys, but the genitals, organs, and peritoneum were free from infection. The infant, born about the sixth month of intra-uterine life, lived for twenty-six days in the couveuse, and then died, having lost weight, but having shown no other sign of illness. At the autopsy no peritonitis was found, and the intestine was free from lesions; but in the liver were numerous yellow granulations, in the spleen were crowds of the same punctiform granulations, and in the lungs were small numbers of gray, transparent granulations. The bronchial glands also were tubercular. Microscopic examination revealed an excessive number of tubercles in the liver, some caseated in the centre, with an enormous quantity of the bacilli of Koch. The spleen showed similar changes, there was tubercular endocarditis in the right ventricle of the heart. There were no giant cells. The placenta was also tubercular, and animals inoculated with pieces of it, and with the fœtal organs, developed tuberculosis. In this case there could be no doubt that the fœtus had become infected with tuberculosis. The reason why such cases are rare is probably to be found in the fact that in order to reach the fœtus the bacilli must be in the blood stream, and that they seldom are there unless the tuberculosis of the mother has become generalised. Further, many cases of fœtal tuberculosis may have been passed over because the lesions were looked for in the lungs, where on account of the mechanism of fœtal infection they are very seldom to be found. That the fœtal tissues are a suitable soil for the growth of the tubercle bacillus is proved by the extraordinary proportions of the bacillary invasion in the cases that have been reported. That the tubercle bacillus may be carried directly into the organism by the sperm has been affirmed, but manifestly the complete proof is surrounded with almost insurmountable difficulties.

The fœtus is liable to *toxicological states* transmitted to it from the mother through the placenta; but regarding these comparatively little is known. Much yet remains to be discovered regarding the effect of alcohol, absinthe, lead, mercury, copper, and the like taken into the maternal system upon the health of the unborn infant. It has been experimentally demonstrated that in the case of guinea-pigs the placenta has a tendency to store up copper and mercury, but not lead, which passes easily and completely through to the fœtuses; arsenic passes with greater difficulty, mercury apparently not at all, and copper, although it is accumulated in the placenta, also passes through it. It is interesting to know that lead, after it passes, tends to be stored up in the nervous system of the fœtus, while arsenic goes to the skin. From what has been experimentally determined regarding the teratogenic powers of alcohols injected into the hen's egg, it may be hazarded that it is possible that they may have a similar effect upon the mammalian embryo.

The *so-called* TRAUMATIC STATES OF THE FŒTUS include congenital fractures, dislocations, and amputations. The *fractures* that are met with in the infant at birth are usually due to the birth-traumatism, although they may have been predisposed to by truly antenatal fragility of the skeleton, as in the various conditions to which the name "fœtal rickets" has been loosely applied; that true fractures may occur in intra-uterine life long before the onset of labour has been asserted, chiefly on the strength of the observation of the so-called cases of cured fracture noted after birth. That maternal falls and blows may by direct pressure or by contre-coup cause fœtal fractures, which afterwards consolidate in a vicious position and with much callus, is freely stated, but exact proof is not forthcoming. There is indeed reason to believe that some of these badly united fœtal fractures may be due not to external violence, but rather to the effect of amniotic adhesions or pressure. This, at any rate, would account for the association of the fractures with such malformations as the absence of one of the neighbouring limb bones, an association which is far from rare. Congenital *dislocations* may also be due to the traumatism of labour, but truly fœtal dislocations are in all probability rather to be regarded as the results of malformation than of injury. Dislocation of the hip would appear to be the commonest and the most important of the congenital luxations. According to one theory of origin, it is due to amniotic pressure upon the neighbourhood of the hip; according to another, there is an intra-uterine destruction of the tissues of the joint; another hypothesis regards it as caused by primary alterations of the nervous system producing either retraction or paralysis of the peri-articular muscles; while yet another view is that it is really an arrested development of the acetabulum and surrounding parts, and not a dislocation in the true sense of the word. A great deal has been done of late years to correct this dislocation after birth, but as yet it is not settled whether the operative measures of Hoffa and Lorenz (enlargement of the acetabular cavity) or the bloodless method of Paci (reduction under chloroform and fixation by a plaster of Paris bandage) offer the better chance of success. Congenital dislocation of the knee, with or without absence of the patella, is not so common as dislocation of the hip; in it the head of the tibia may be displaced forward on the femur and give rise to hyperextension of the joint (genu recurvatum); occasionally, but rarely, lateral dislocation has been met with, and recently two cases have been recorded in which there was spontaneous and recurrent lateral luxation of the knee. Congenital dislocations of the patella, shoulder, and elbow have been noted, but they are very rare.

Congenital amputations are scarcely amputations in the usual sense of the term. The name is applied to the cases in which one or more digits, or even a hand or foot, or part of a limb is wanting at birth; and the explanation which has been commonly employed to account for the anomaly is that the umbilical cord or an amniotic band has become twisted round the part and has caused first a groove, then a deep furrow, and finally has entirely separated the portion of the limb lying distal to the constricting band. It is possible, however, that simple pressure of a tight amnion on the limb-bud may have hindered development, and so prevented the formation of the part. If this latter view be correct, the amputation is rather a malformation. It may be added that the condition has also been ascribed to a pathological state of the skin and subcutaneous tissue of a sclerodermic kind, and the disease called ainhum has been referred to as the corresponding morbid state in the adult. There seems to be little doubt that amniotic bands have something to do with the so-called spontaneous amputation; at any rate, amniotic adhesions and bands coexist with congenital amputations. It is a striking fact that in some of the recorded cases of amputation of digits there seems to have been an attempt at reformation of the missing parts; for instance, at the end of the forearm there have been seen small fleshy tubercles supposed to be rudimentary fingers. In conclusion, it may be said to be doubtful whether congenital amputations belong to the pathology of the fœtus or of the embryo, whether they are pathological or teratological.

INTRA-UTERINE DEATH OF THE FŒTUS,

Like post-natal death of the child or adult, may be due to very many *causes.* Attempts have been made, not always very successfully, to group these causes into maternal, paternal, and fœtal; probably in the great majority of cases the immediate cause of death is some lesion of the placenta, although it must be admitted that occasionally the placenta is apparently quite normal, even where there is good reason to believe that fœtal death had occurred some time before birth. Among the maternal causes of fœtal death may be enumerated endometritis and displacements of the uterus; acute febrile diseases such as pneumonia; acute infectious fevers, such as variola, cholera, typhoid fever, typhus; heart disease, nephritis; injuries, accidents, and operative and criminal interference; and, very specially, syphilis. A high maternal temperature, if it has been gradually reached, does not necessarily prove fatal to the unborn infant; but if the rise has been rapid as well as great, intra-uterine death usually follows. Purely paternal causes are little understood, although there can be no doubt about their existence; the best known is syphilis (the mother remaining unaffected); and others which have been enumerated are albuminuria, chronic lead poisoning, and old age. There seems to be no doubt that the various fœtal diseases that have been referred to above may all be the causes of fœtal death; but it would also seem that the fœtus may be very seriously morbid, and yet live on in utero so long as the placental tissue is normal and the circulation in the umbilical cord not interfered with. In fact, as has been already stated, the integrity of the placenta is the great safeguard of fœtal life; consequently, when the placenta is the seat of hæmorrhages or of fibrous or myxomatous changes, intra-uterine death is very probable. Convolutions and knots of the umbilical cord, unless drawn very tight, do not produce fœtal death. Habitual death of the unborn infant is an occasional and a very distressing occurrence; its causes, in order of frequency, are syphilis, maternal anæmia, uterine diseases and displacements, alcoholism, renal and cardiac maladies, and "individual predisposition." Occasionally habitual alternate death of the fœtus may be recorded, and sometimes it has been noted that only fœtuses of the male or of the female sex died in utero, those of the other sex being born alive.

There seems now to be no doubt that intra-uterine death, like post-natal death, is followed by rigor mortis; but it is quite likely, that on account of the feeble development of the muscular system, the rigidity may be less marked and of shorter duration than that seen in the adult or child. If fœtal death occur between the third and fifth months, the commonest post-mortem change would appear to be mummification, a drying up and shrivelling of the fœtal tissues without putrefactive breaking down. If such a mummifying fœtus be subjected to pressure, either from a tumour in the uterus or (more commonly) from a living and growing twin, then it becomes flattened and is known as the *fœtus compressus s. papyraceus.* Maceration is the commonest result of intra-uterine death in the later months of gestation; it also is a non-putrefactive process. It is characterised by a softening of all the tissues and an infiltration of them with blood-stained serum; by desquamation of the cuticle, and by the formation of blebs or bullæ on the skin which contain yellowish fluid; and by the presence of blood-stained serum in all the body cavities. There may also be the changes due to the disease from which the fœtus succumbed, *e.g.*, in syphilis, the yellow line at the junction of the shaft and epiphysis of the long bones due to osteo-chondritis. The umbilical cord is often swollen and the placenta atrophic or œdematous, while the liquor amnii is of a dirty green colour from expelled meconium. Rarely true putrefaction occurs in utero with the development of gases; it is usually subsequent to rupture of the membranes, for the germs of putrefaction very uncommonly gain entrance save through the vagina of the mother. Calcification is very rare.

The *diagnosis of intra-uterine death* is one of the most difficult tasks that fall to the lot of the obstetrician. As a rule, the dead fœtus is expelled from the uterus about fourteen days after it has succumbed; then, of course, the expulsion of the dead and macerated body enables the diagnosis to be made. But sometimes the dead infant is retained for weeks and even for months in utero, and it becomes as important as it is difficult to be sure that death has occurred, and that we are not dealing with some other condition, *e.g.* a tumour of the uterus. There is no one certain sign of fœtal death similar to the certain sign of fœtal life (the hearing of the fœtal heart); and the diagnosis must be largely based on negative signs and symptoms. Among the circumstances which help in the formation of a diagnosis may be enumerated the history of the occurrence of fœtal death in a previous pregnancy in the same patient; the presence of syphilis or of some acute febrile or infectious disease, or the incidence of a traumatism, and, in a word, the existence of any well-known cause of fœtal death; the presence of various vague maternal sensations, such as a feeling of coldness and weight in the pelvis, absence of fœtal movements, especially following upon a period of unduly active movements; diminution in the size of the abdomen and uterus, retrogressive changes in the mammary glands and abdomen, occurrence of passing labour pains, impossibility of hearing the fœtal heart and of detecting fœtal movements; the disappearance of various grave symptoms, such as vomiting and albuminuria, which had been in evidence before the death of the fœtus; and, finally, it is possible that the occurrence of acetonuria and peptonuria may assist in the making of a provisional diagnosis. The treatment of intra-uterine death is intimately associated with the treatment of the causes of it (maternal, paternal, and fœtal). As a matter of experience, the birth of a dead fœtus does not seem to be attended with much danger, a fact which is explicable by the aseptic nature of the post-mortem change and by the involutionary changes in the placenta and uterine walls which usually precede the expulsion of the infant.

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Affections of the Generative Organs

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Cancer, Fibroid Tumours, Ovarian Tumours in Pregnancy

THE course of pregnancy and of labour may be seriously affected by anomalous conditions of the uterus and vagina due to defects of development, to abnormal positions of the organs, and to pathological changes in their tissues. When such cases occur, questions of grave importance may arise as to the risks which the patients run, and the proper means of management. What concerns us at present is not so much the discussion of the ever changing views regarding treatment, as the clinical recognition of those defects, and the experience which has been accumulated as to their influence on pregnancy and dangers that may occur, or in other words, the knowledge upon which the solution of questions in individual cases should be based.

1. Malformations of the Uterus and Vagina.—The nature of the various anomalies of the generative tract and their clinical features can be readily understood by remembering the origin and development of the organs from the two Müllerian ducts. All the varieties are explained by the retention in whole or in part of this duplex character, and by an imperfect development of one-half in comparison with that of the other. Normally the union is complete from below as high as the Fallopian tubes, between which is developed the fundus uteri, whilst by total absorption of the septum the uterine body, the cervix, and the vagina form a single canal. In any of these respects, throughout, or at any one part, the development may be imperfect, and so are produced the various anomalies that have now to be noted.

The *fundus* alone may be imperfectly formed, and show a flattening or depression instead of the usual convexity—*uterus arcuatus, s. corduatus.* This defect may be associated internally with some remains of the septum. Pregnancy is not affected thereby, but it may have an influence in the production of malpositions of the head (Auvard), and where a partial septum is present to difficulty with the placenta.

Other abnormalities arrange themselves under various types, the distinctive characters of which may be more or less pronounced in different cases.

Uterus Septus.—Here the external formation is normal, with perhaps a slight increase in width, but the septum remains, dividing the cavity more or less completely into two. The septum may be only partial, *uterus subseptus,* or it may extend to the internal os, or even into the cervical canal, but the external os is single.

Uterus Bicornis.—Here the duplex character is indicated externally by the uterine body being divided into two distinct cornua, at a varying height above the cervix, each horn terminating in its own Fallopian tube, but with a common cervix, the canal of which may be single or double.

Uterus Didelphys.—In this rarest variety the separation is complete, two single uteri lying side by side, each possessing its own os uteri and cervical canal, but only one tube, ovary, and round ligament. The vagina may be single, or duplicated in whole or in part. It is doubtful if pregnancy occurs in this variety.

Uterus Unicornis.—Where one-half has been well developed, presenting a spindle formation ending in the Fallopian tube, the other half remaining in a rudimentary state or imperfectly developed form.

In any of the above duplex conditions one-half may have no communication with the general canal. The menstrual fluid in that half will then be retained, giving rise to a tumour the nature of which may be difficult to diagnose.

The *vagina* may be double throughout, even when the cervix and uterus are single; or partial remains of the septum may be present, forming a band of tissue across the canal.

Such anomalies in development do not interfere with the possibility of pregnancy so long as ovulation takes place, and there is no occlusion in the generative tract. If, on the other hand, the impregnated ovum is prevented entering the uterine cavity, the case belongs to ectopic gestation. In the same category must be placed the rare cases where the ovum has been lodged in an imperfectly developed half, having no communication with the fully developed horn or the vagina. In such a case rupture into the peritoneal cavity is likely to occur about the third or fourth month, or if the fœtus dies before rupture, it may be indefinitely retained.

Diagnosis.—With a double or one-horned uterus, pregnancy is not uncommon—much more frequent, indeed, than is recognised. From various circumstances, the condition may very readily be overlooked. As a rule, the course of pregnancy is not disturbed, and labour is easy and natural, and in some forms, as in the uterus septus, the abnormality can be discovered only when occasion calls for the introduction of the hand into the uterus. Even where it might be possible in the non-gravid state, or early pregnancy, to recognise the condition from the abnormal shape of the uterus, this may be considerably obscured in advanced pregnancy or in labour. In a uterus unicornis the spindle shape is much altered, and in uterus bicornis, where one horn only is pregnant, it may lie in front of and conceal the other.

A double vagina calls for careful examination of the uterus; for although it may be present with normal conditions above, it is always a possible indication of other anomalies. The presence of two os uteri and complete double vagina are sure signs of a duplex uterine cavity.

When both divisions are pregnant, a diagnosis can more readily be made. A furrow more or less marked may be detected between the two halves where they are united in one body; where the horns are distinct they diverge from one another, more especially when the uterus contracts.

Other conditions suggestive of a double uterus are referred to below.

Phenomena and Course of the Pregnancy.—The pregnancy may be single or double, spoken of as unilateral or bilateral, *i.e.* where one or both horns are occupied. Twins have also been met with occupying the same horn, and in the uterus unicornis. When both cornua are occupied, the ova may have been impregnated at different times, even at considerable intervals (*superfœtation*), and the fœtuses may show at birth a corresponding difference in development, or the one fœtus be retained *in utero* for some weeks after the birth of the first. In all such remarkable cases, a careful examination of the uterus should be made to ascertain the presence or not of a duplex uterus.

When one-half of a double uterus only is gravid, the other, to some extent, shares in the hypertrophy of the walls, and a decidua may be formed in it. Under such circumstances it is possible that considerable or repeated hæmorrhage may occur during the pregnancy, from the empty half, without endangering the gestation. An explanation may thus be afforded of cases where it has been stated that menstruation has regularly recurred during pregnancy, or that the woman menstruated only while pregnant.

During labour, both divisions have been felt to contract and relax simultaneously. Where there were two os uteri, that of the empty half has been observed to dilate and a decidua to be expelled. At the same time each horn may be functionally distinct and contract independently of the other.

Though the labour is generally easy and natural, yet anomalies are more frequently met with. That a greater tendency to abortion exists does not rest on satisfactory evidence. It is in labour that difficulties are likely to be experienced. The increased inclination of the uterus is liable to affect the position of the head; breech and transverse presentations are more frequent than in single uteri. The labour may be rendered tardy from the direction of the uterine force not closely corresponding with the axis of the brim. The upper portion of the horn differs from the natural fundus uteri; the walls may be thinner, and the risk of rupture is greater.

Difficulties with the placenta are liable to occur when it is situated in the upper part of the horn, or is attached to the division in the uterus septus. Hæmorrhage in the latter case is likely to follow the separation. When the septum is incomplete, the placenta has been found in the one division, whilst the fœtus in its development has passed into the other.

Bands of tissue in the vagina have caused difficulty in the second stage of labour. Where such is the case, it is better to divide them artificially than leave them to be torn by the natural forces, the risk of the laceration extending into the vaginal wall being considerable.

2. Abnormalities in Position and Relations of the Gravid Uterus.—The gravid uterus has, at rare times, been found in strange quarters, as in the sac of *an inguinal or femoral hernia.* Under such circumstances gestation is likely to be arrested; cases have, nevertheless, been recorded where a child has been delivered by hysterectomy and survived. Considering the risks to the mother, such cases, as soon as recognised, would in the present day come at once under the surgeon's knife.

In the later months of pregnancy the fundus uteri may come into relation with a pre-existing *umbilical hernia* and partially protrude into the sac; in one case two-thirds of the organ is said to have so passed. Labour will not be complicated unless adhesions have been formed interfering with retraction; in one recorded case retention of the placenta in the hernial sac caused difficulty.

A uterus liable to *prolapsus* or *procidentia* may become pregnant. With ordinary care the displacement disappears with the increasing size and elevation of the organ. A complication may arise where the enlarged uterus by a sudden strain has been forced out, and, from its size, difficulty is experienced in returning it. If unreduced, symptoms of incarceration and abortion would ensue. In older writings, cases are recorded where pregnancy in a supposed prolapsed uterus had advanced to full term; but these have evidently been cases where the prolapse has been limited to the cervix alone, from great hypertrophy, the uterine body remaining within the pelvis. The position of the fundus in the cases recorded is not stated. Acute œdema of the cervix may also simulate prolapsus during pregnancy, and also after labour. Prolapse of the anterior vaginal wall may be a source of much discomfort during gestation, and demand attention in the management of the labour.

A uterus that has been the subject of complete prolapse, but now retained in the pelvis by pregnancy, is liable to assume a retroverted position and cause further trouble. This must be borne in mind when replacing a prolapsed gravid uterus.

Versions and Flexions.—At one time there was a tendency to impute prejudicial effects in pregnancy to *flexions* of the uterus, and so regard as pathological a condition that often exists, but in no way interferes with gestation. The same may be said of *anteversions* in the earlier months. Frequency of micturition and other inconveniences may arise from the pressure of the enlarging uterus, but these diminish when the organ rises above the brim; incarceration in this position does not occur. Some degree of flexion is almost always present in cases of version, but it is the latter only that endangers the pregnancy, as is shown by the relief obtained by correcting the version, whilst the flexion is left, and in fact cannot be treated.

PENDULOUS ABDOMEN.—*Anteversion of the Uterus in the Later Months of Gestation.*—In the earlier months of gestation anteversion, as before stated, causes no difficulty; it is in the later months the condition becomes of importance, and is then more graphically termed and better known as pendulous abdomen. It is in general due to relaxation of the abdominal walls owing to previous pregnancy, and is certain to be present when separation of the recti muscles has occurred either from child-bearing or after cœliotomy. It may, however, be present in a primigravida, and is then suggestive of narrowing or other deformity of the pelvis.

The course of pregnancy is not disturbed thereby, but difficulties and even grave complications in labour are liable to arise from the resultant of the uterine forces deviating considerably from the line of the axis of the inlet. Tardy dilatation of the os uteri, malposition of the head, the presenting part refusing to enter the brim, consequent exhaustion of the uterus from ineffectual action, and even rupture of the uterus, may occur.

Placing the patient on her back, elevating the uterus, and applying a binder, is the proper treatment.

RETROVERSION OF GRAVID UTERUS.—Although retroversion may at times be the cause of sterility, it is no certain barrier to impregnation. With the natural growth and elevation of the uterus, the displacement is often undone, and the pregnancy is not interrupted. But this is not always the case; abortions are frequent and often repeated when the uterus is retroverted. This can readily be understood; for the mucosa and blood-vessels of such an organ are not likely to be healthy, or, if previously healthy, the uterine circulation is so impeded that hæmorrhage is very liable to occur.

The usual pelvic symptoms—discomfort, fulness, weight, dragging, or pain—gradually increase, relieved by lying down. Amenorrhœa and other signs of pregnancy are present, but obscured, it may be, by slight shows of blood at intervals. Bimanual examination reveals the readily recognisable signs of retroversion.

It is never safe to trust to the natural process of righting the position. In uncomplicated cases during the first three months the version can often be corrected *manually*, without difficulty, and a Hodge or ring pessary carefully fitted. Examination must be made from time to time to ascertain that the pessary has not got displaced. It is unnecessary to persist in attempts to get the uterus into the theoretical "normal" position: all that is necessary is to secure, if possible, that the fundus is on the same or a higher level than the cervix; the body may still be retroposed; if the tendency to prolapse be corrected by a pessary, nature will do the rest. The patient should lie as much as possible in the semiprone position, and avoid the necessity of straining at stool by the regular use of saline aperients.

Incarceration of the Gravid Uterus.—When a case of pregnant retroverted uterus has not received attention, and the natural growth and elevation has not corrected the version, more serious pressure symptoms arise, indicating *incarceration.* They begin in the third or early in the fourth month, when the increasing bulk of the uterus becomes too great for the pelvis. This is more likely to happen when a marked degree of prolapse has been associated with the version, or a projecting promontory narrows the inlet. The patient, who previously has complained of the frequency of micturition, may find herself unable to pass water. The complete retention may come suddenly, or after several successful efforts. The bladder becomes distended; there is acute hypogastric pain, paroxysmal in character. The nature of the case may be overlooked from the patient stating she has been constantly passing water—the dribbling of an overfilled bladder. General distension of the abdomen, with tenderness on pressure and vomiting, may further obscure the case.

When unrelieved, serious complications have occurred: cystitis, sloughing of the mucous membrane, and gangrene of the muscular coat of the bladder, distension of the ureters and kidneys, with consequent uræmia or septicæmia, have all been recorded.

The Diagnosis.—Given the history of a possible pregnancy in the third or fourth month, urinary troubles, a central abdominal tumour which the use of the catheter has demonstrated to have been a distended bladder; per vaginam, the pelvis occupied by a rounded spherical tumour which may vary in consistence, and the cervix high up in the front, lying against and looking towards or above the symphysis—the diagnosis should not be difficult.

Differential Diagnosis.—Nevertheless, the same effects may arise under different circumstances. A tumour similar in size, shape, and position, and causing retention of urine, may be formed by the sac of an extra-uterine pregnancy, or the hæmorrhage due to a tubal abortion, by a retropubic abscess, or by a small ovarian cyst distending the pouch of Douglas. In the first two cases there will be some evidence of pregnancy, and the differential diagnosis is mainly dependent upon careful bimanual examination. When the tumour is outside the body of the uterus the latter is pushed bodily forwards, and may be defined in front of the tumour, and the axis of the cervix directed *downwards* instead of forwards towards the symphysis pubis. In the other conditions, besides the same physical signs, there is not likely to be amenorrhœa or other signs of pregnancy.

Treatment.—The first step is to empty the bladder. Difficulties are sometimes met with here. The points to attend to are, to use a gum elastic catheter, not a glass or other rigid one, or one of soft indiarubber; the passing the instrument must be carefully guided by a finger in the vagina passed well up in front to the cervix; and, lastly, to remember that from the drawing up, stretching, and elongation of the urethra, the instrument may have to pass a greater distance than usual before the water is reached.

It is not well in all cases to proceed at once to attempt rectification of the position of the uterus. It is advisable to have the bowels well acted upon by a saline purge, not merely emptied by enemata. Further, the pelvic vessels are certain to be distended, and the tissues more or less œdematous. These conditions are relieved by the saline, and by rest for some hours in the semiprone position. After this preliminary treatment, rectification should be tried.

With the patient in a favourable position—semiprone or knee-shoulder—and in some cases under an anæsthetic, the operation is at times readily effected; at others, repeated trials have to be made. After a failure of this kind, it not unfrequently has been found that the uterus has spontaneously rectified itself, or that the desired effect has been obtained by the introduction into the vagina of a hydrostatic bag or elastic ring pessary. No doubt the manipulation in the futile attempts may have modified the conditions that caused the incarceration, but the fact that means so simple have effected replacement, after careful taxis has failed, is interesting and instructive. The lessons it teaches are, that the difficulty in most cases is not to be overcome all at once by strenuous efforts; that the primary idea under which to work is not to secure immediate elevation of the fundus above the brim, but to *correct the version and prolapse;* effect this, even partially, and nature will likely do the rest. To accomplish the necessary rotation of the uterus upon itself with a minimum of force, two forces are required: one acting upwards on the body of the uterus, the other downwards on the cervix. The latter is the more difficult to apply. Through a thin abdominal wall pressure may be applied externally above the pubis, or the finger internally may exert sufficient pressure on the cervix, but it is difficult to get a purchase in this manner. Failing these, a hold may be taken of the anterior cervical lip with a button volsellum; it does not wound the surface, but no great force should be exerted, lest the tissues be torn. It is not the amount, but the direction of the force that is effectual.

Very instructive also are the good results obtained by Professor Playfair, who used a hydrostatic bag in the vagina, and by Professor Japp Sinclair, who introduces an ordinary watch-spring ring pessary. He reports fifteen consecutive cases without a failure. Now such instruments cannot exert a force sufficient of itself to elevate the fundus, such as is artificially applied in the ordinary taxis. An elastic pessary lying in the vagina may exert some pressure, but the direction is backwards towards the hollow of the sacrum, not upwards towards the brim. Then again, in seeking to explain their action, the fact must not be lost sight of, that, after a futile attempt at rectification, the natural processes have spontaneously righted the uterus. It is the latter that are the active agents: the action of a pessary is passive. A pessary is not a lever, as has often been supposed; it may, however, act as a fulcrum. During pregnancy, the natural forces normally tend to elevate the fundus, even when retroverted; but in certain cases this tendency is reversed—the cervix is elevated, the fundus is more and more depressed. The factor in such cases that has been hitherto disregarded is in all probability the varying degree of prolapse that is associated with the retroversion. By the introduction of artificial support from below, the tendency to movement in the wrong direction is corrected, and the natural powers so enforced rectify the malposition.

The disastrous effects that occasionally have been met with arise from carelessness in examination, and late recognition of the real nature of the case. The more the above facts are recognised, the less strenuous will be the attempts at immediate rectification, and rarer the occurrence of irreducible cases.

Irreducible Retro-displacement.—With the present greater appreciation of the value of rest, the use of anæsthetics, and the greater knowledge of the natural powers, aided, it may be, to overcome the obstruction, it must indeed be rare to meet with a case that must be pronounced irreducible and demands further interference. Yet such cases have, and possibly may again occur. Strong adhesions may be the cause. Left unreduced, serious consequences are certain to arise.

Abortion may be induced; but the conditions render the operation difficult and liable to be incomplete, and to be followed by inflammation and sepsis. Olshausen and others have removed the whole uterus by the vaginal method. But in the present day, if the more rational methods have failed and urgent symptoms threaten, cœliotomy, separation of any adhesions, and pulling up the uterus, is undoubtedly the preferable operation, and one that may not interrupt the pregnancy. This has been done eleven times by Jacobs, surely in some cases unnecessarily, and once by Murdoch Cameron of Glasgow, and others. But cases requiring such a proceeding must be very rare.

SACCULATION OF THE GRAVID UTERUS.—*Partial Retroversion or Flexion.*—In the advanced months of pregnancy, cases are at rare times met with where the cervix uteri is displaced upwards close behind or above the symphysis, difficult to reach, and the pelvis occupied by a tumour which careful examination proves to be the posterior uterine wall containing the presenting part of the fœtus, whilst above the uterine body and contents form a well-marked abdominal tumour.

The condition can be realised by supposing a retroverted pregnant uterus which has been but partially righted, the cervix high up behind the pubis, the lower part of the posterior wall remaining in its abnormal position, whilst the anterior wall has been developed and stretched sufficiently to allow the upper pole of the fœtal body to rise into the abdomen.

Such, too, is the probable origin, in some cases, of the condition. It has, however, been found associated with an ovarian tumour (Croom), and with fibroid tumours of the uterus (Dührssen and Munro Kerr). Scanzoni has observed it along with pendulous abdomen, to which condition he ascribes it.

Pressure symptoms are liable to be troublesome. Barnes reports a case where the ureters became involved.

Spontaneous rectification has been observed before and also during labour. The pelvic tumour has also been successfully pushed up, and the cervix brought to its normal position, during gestation. Labour may not ensue till full term, but is liable to be premature.

An analogous condition affecting the *anterior* wall may be met with. The cervix is then far back and drawn upwards—to be reached only by introduction of the hand into the vagina under anæsthesia. Such cases have been mistaken for pathological occlusion of the os, and the cervix incised.

If reduction has not been effected before labour sets in, the first stage is certain to be protracted. The uterine force cannot act directly on the os uteri. The presenting part should be pushed up, artificial dilatation of the os used, and the anterior lip drawn forward or the posterior pushed back, according to the condition. Version or the forceps may be employed, careful support being given to the cervix during extraction.

PATHOLOGICAL CHANGES

CANCER OF THE UTERUS AND PREGNANCY.—During the child-bearing period, cancer of the *body* of the uterus is very rare: pregnancy in this condition probably never occurs. If it did, an early abortion would almost certainly result, and would likely be unrecognised, as the pain and hæmorrhage would be assigned to the pre-existing disease, and the evidence of the conception lost in the discharges.

The same, in all probability, often happens when the *cervix* alone is involved. But that pregnancy may occur under this condition and advance to the full term there is but too ample evidence.

To the medical attendant, a case of pregnancy complicated by carcinoma of the cervix uteri must be throughout a cause of anxiety, so numerous are the risks, and uncertain the course of gestation and progress of the disease. At the same time, the conditions and results in different cases are so varied, that it is difficult to arrive at any reliable conclusions to guide in determining what in a special case will be best for the patient. An analysis of a large number of cases is the only reliable aid. This will be found in a valuable paper by G. Ernest Herman in the *London Obstetrical Transactions*, vol. xx. p. 191, 1878. Since it was written, however, the advance of surgical technique and skill has modified some of the conclusions arrived at.

It is now generally accepted that pregnancy *stimulates the activity of the morbid growth*, though at one time the opposite was believed. Whether the pregnant state, apart from any injurious effect of labour, hastens or retards the general constitutional changes which directly lead to a fatal issue, has not been determined. Certainly the presumption is that the prognosis would be more favourable without the pregnancy, and not made worse by the gestation being ended. The improvement that has often been observed after the puerperium is past supports this view.

The frequency of *abortions* and of *still births* is increased, and labour is more apt to be *premature;* the prospects of the child are therefore considerably lessened. These considerations must have weight in considering, in a case, the advisability of artificially emptying the uterus.

In the early months of pregnancy, and in an early stage of the disease, where one otherwise would recommend *hysterectomy,* the existence of the pregnancy should be no barrier to the operation. Delay is dangerous, as by the time the child is viable, the disease, as has happened, may have so advanced as to contra-indicate any attempt at removal of the organ. But in the later months, if the child has nearly reached a viable age, and hysterectomy is deemed suitable, the mother should take the risk of a short delay rather than wholly destroy the chances of the child.

Where hysterectomy is inadvisable, or the consent of patient and friends is refused, it may be possible to remove the greater part, if not all, of the diseased structure where it is still circumscribed and the neighbouring tissues are not infiltrated. The dangers are not greater than in the non-gravid condition, and the risk of inducing abortion has proved to be slight. The prospects of the patient are greatly improved; gestation may go on to full term, and end in a labour easier than otherwise it would have been. Even if abortion did follow, it is the step which, without the operation, might be advisable. It is now generally accepted that before the sixth month, where the disease cannot be wholly removed, the *induction of abortion* offers the best chance to the mother.

The tolerance of the pregnant uterus to operations on the cervix enables one to meet a complication, where it has been decided to allow gestation to run its course. Severe or repeated hæmorrhages may seriously affect the patient's strength. The ragged and cheesy surface can be removed with the curette, well into the canal, but not to interfere with the internal os and membranes, and the cavity thereafter plugged with iodoform gauze. The bleeding can in this way be checked, and the pain from which the patient has suffered is often relieved.

In thus operating on the cervix, even when removing considerable portions of the diseased structure, bleeding is seldom considerable, and is easily restrained by pressure of the tampon.

When the pregnancy has advanced beyond the sixth month, one of three courses can be adopted:—1. To induce premature labour; 2. To wait till labour ensues spontaneously, and then meet the difficulties as they arise; 3. Cæsarean section when labour begins, or previously at a determined time. The position of the latter operation is very different from what it was ten years ago. It can now be performed with comparative safety. It is no longer the last resort where it is impossible to deliver the patient by other means, but is to be preferred in all cases where delivery by the natural passages, though possible, is certain to entail the dangers of a protracted labour with much bruising and tearing of the tissues. The interests of the child also are better safeguarded.

The question of treatment, therefore, turns on forecasting the probable difficulties of the labour, and the prospect of life to the mother should she survive the confinement.

When the *morbid growth is limited* and a fair portion of the cervical tissue is free, the anticipation of difficulty is not great. It has not infrequently been found that when even the whole circumference of the os uteri was involved, dilatation has been accomplished by the natural efforts, tardily it may be, but successfully, and the patient made a good recovery. It would appear that difficulty in full dilatation does not depend upon the extent or size of the growth so much as upon its consistence; if the cancer growth be soft, and the surrounding tissues but little involved, it will not offer much resistance to the uterine force, aided if need be by the forceps. The expansion in most cases is finally attained by *fissuring,* and this does not seem to increase the dangers to the mother.

Following this indication of nature, *incisions with scissors* have been made with marked benefit, and are probably to be preferred to trusting wholly to accident. This procedure has proved more reliable and safer than attempts to dilate with indiarubber bags.

There are cases, however, where the risks likely to be encountered are more hazardous than the *Cæsarean operation,* especially where the morbid growth is extensive and hard, or the neighbouring tissues are infiltrated. In no case should the decision be made to trust to natural efforts without a careful *examination per rectum,* as well as by the vagina; much more information can thus be gained of the amount and consistence of the parts involved.

It should be noted that in labour it has at times been possible to remove considerable portions of the cancerous growth without injurious effect, and labour in this way accomplished. Successful cases have been recorded, but also unsuccessful, and in these the feeling must be that in the present day Cæsarean section would have been preferable.

It has been argued that in cases where difficulties are likely to be met from the state of the cervix, *premature labour* should be induced, as the obstruction will increase rather than lessen by waiting, and the fœtal head will be larger. To the mother, any benefit to be gained is slight, whilst to the child, whose claims are now paramount, the risks would be increased by prematurity and the difficult delivery. Cæsarean section conserves its interest, and can be done if the dreaded increase in the obstruction has occurred, and is to be preferred where otherwise craniotomy is the only resource. In the milder cases, forceps are safer to mother and child than turning.

FIBROID TUMOURS AND PREGNANCY.—Small round myomata are often present in the pregnant uterus, and cause no trouble. Even when multiple, if distributed and not massed together, or if single and of moderate size, they may not influence the pregnancy or complicate labour, provided they do not distort the uterine cavity or obstruct the passages, and no untoward change occurs such as described below. These cases do not call for interference. Uterine action is not impaired, as has often been stated; but there is risk of malpresentations. Hæmorrhage, too, is likely should the placenta be attached in the situation of the tumour. The bleeding, in such a case, might be difficult to control; probably this is one condition where packing the uterine cavity would be preferable to the ordinary hæmostatic measures.

Different is the prospect where the tumour is situated in the lower uterine segment or cervix, and lying in the pelvis or immediately above the brim, dangerously narrowing the canal, or preventing the fœtal head engaging the brim. Cases have been recorded where a tumour so situated has in labour been drawn up by uterine action or pushed up by the attendant, and the labour successfully terminated. So fortunate an occurrence as the first cannot be reckoned on, whilst the use of strong artificial force has proved injurious or futile as often as it has been successful. If the tumour is in the anterior wall, it may possibly be drawn or pushed up, as this accords with the natural mechanism of labour; but in the posterior wall no such natural movement takes place, elevation is then possible only when the tumour is peduncular, and such a condition might be inferred when it is known from a recent vaginal examination that previously no tumour occupied that situation.

The presence of uterine fibroids is recognised as a cause of *repeated hæmorrhages* during gestation, and also of *abortion.* When the uterine cavity is distorted by the mass, or the cervix involved, much difficulty may be experienced in completely emptying the uterus. When curetting has been necessary, or there is fear that small portions of membrane have been retained, thorough washing out the uterus should be repeated daily till all risk is past.

Uterine myomata increase in size with the growth of the uterus, and when all goes well they share in the process of involution. But during this growth serious effects may ensue, causing much suffering, and even endangering life. Some are purely mechanical; others are due to pathological changes.

Pressure Symptoms.—Exhausting pain, obstruction of bowel or bladder, or local œdema, may set in. *The relation of a myoma to the lower segment or to the pelvis* may change, so that, whilst at an early period of pregnancy no obstruction was indicated because of the high position, yet before full term is reached it may have descended so as dangerously to narrow the canal.

Pathological changes in the myomata not infrequently occur. *The rapidity of the growth may be out of all proportion to that of the uterus.* The tumour takes on an independent action, leading to pathological changes in its structure—softening or cystic—and to morbid action in contiguous tissues, especially peritonitis with adhesions. The tumour may continue to grow after delivery, or degenerative or septic changes ensue, with consequent blood-poisoning, or extreme emaciation as in malignant affections.

Subserous pedunculated myomata are especially liable to degenerative changes, and to contract adhesions to neighbouring organs—probably from twisting of the pedicle or other interference with nutrition whilst under the stimulus of pregnancy. They are apt to slip down into the pelvis behind the uterus, or to one side, and form a formidable complication in labour. Their treatment will be discussed later.

Obstruction to the passage of the child, then, is not the only point in the determination of the question of interference. The liability of pathological changes in the tumours adds fresh complications. Undue rapidity of growth, softening, or inequality of consistence, are important elements that of themselves may warrant operation; still more if the woman is exhausted by pain or sickness, febrile attacks, or emaciation.

Treatment.—The improvements in surgical technique, the increased knowledge gained by abdominal sections, and the greater attention paid to the subject in recent years, have considerably modified the opinions and management in vogue in previous times. In this paper the endeavour has been to give the basis upon which the question of interference is based; the time and mode of operation must vary from time to time as experience increases. Various points as to treatment have been referred to above; the following are in accordance with the results of the operations recorded during the last twenty years. Details of the operations cannot be discussed.

As indicated above, there are cases that may be allowed to advance to full term. In these unexpected difficulties may arise in the course of labour. It should be borne in mind that a protracted labour, complicated by myoma ended with difficulty by version, forceps, or embryulcia, is as dangerous, if not more so, than Cæsarean section, or Porro-Cæsarean operation performed under favourable circumstances—that is, before the patient's strength has been exhausted, or futile or protracted attempts at delivery have been made.

"On reviewing Lefour's cases, we find that of 66 which terminated unassisted, 32 ended fatally, or a mortality of 48·4 per cent. Of 35 cases of versions, 21 died, or 60 per cent; while the percentage mortality attached to forceps and embryotomy is 25·9 and 55·5 respectively."—Dr. John Philips, *B. M. Journal*, June 21, 1888.

Induction of abortion or of premature labour naturally suggests itself as the least formidable operation. Experience has shown that it is not so, especially where the cavity is distorted. The placenta is liable to be retained, and in some cases it has been impossible to reach it by the hand. The tumour may also make the use of ovum forceps or the curette extremely difficult. The risk of septicæmia is great. It is not an operation to be adopted without careful consideration. Moreover, a subsequent operation will in all likelihood be necessary.

Removal of the Tumours during Pregnancy.—The advance of surgery has now provided the means of averting the dangers that are imminent and allowing the pregnancy to advance to term. According to their relation to the uterine walls, tumours have now been successfully removed by several skilled operators, and in a large proportion of these without interrupting the course of gestation. Peduncular myoma that are growing rapidly, or undergoing change in structure, or causing pain, should always be removed. The pedicle is liable to become twisted. *Myotomy* in the subserous form has in a few cases been done, but it involves much greater risks.

When the local or constitutional disturbances are severe and threaten to be serious, by *cœliotomy* the condition can be exactly determined. Cases have occurred where a peduncular or otherwise accessible tumour has been found and removed, the urgent symptoms relieved, and gestation not interrupted. In other cases, it proved necessary to remove the uterus with the contained fœtus intact, "Müller's ablation." When uterine conditions preclude pregnancy advancing successfully, this operation should be performed early. It has afforded better results in skilled hands than other operations in the later months.

When the fœtus has reached a viable age, induction of labour, with a possible difficult delivery, has not given good results. No advantage is thus to be gained. When there is room to hope for a favourable delivery, natural labour may be waited for. If there is a fair probability of success with *forceps* they may be cautiously used, but not long persisted in. The case is different from ordinary narrowed brim. The pressure on the resisting structures has caused subsequent sloughing and disintegration with septicæmia. The question of attempting to push an obstructing tumour out of the way has already been discussed. *Tumours accessible per vaginam have been removed during labour.* Such cases must be rare. In judging of the advisability of making the attempt, it must be remembered that, though successful, and the labour terminated, the uterus is left in a condition where metritis and peritonitis are most liable to occur. Peduncular tumours from the interior of the uterus, when found, should be removed.

Cæsarean section, or *Porro's operation*, at times comes to be the only resource to save the woman's life. The mortality in the past has been great; but this has been largely due to the fact that, in the majority of cases, the operation has been done only after the patient has been brought into a very unfavourable state by delay and other unsuccessful attempts at delivery. If performed only as a *selective* instead of *compulsory* operation, the chances are greatly improved. Simple Cæsarean section, under the circumstances, involves greater risks: from the uterus being left, a subsequent operation might become necessary, and there is a possibility that the woman might again become pregnant. The Porro-Cæsarean is in every way preferable. The only condition where it would be impossible is where the cervix is so involved in the morbid growth that a stump cannot be formed. The Cæsarean section alone must then suffice. (See also vol. viii. p. 537.)

Ovarian Tumours in Pregnancy.—An ovarian tumour constitutes a formidable and, as seen from the large number of cases recently published, a not uncommon complication of pregnancy. Any of the forms of ovarian tumour may be met with, but the relative frequency of the various kinds is somewhat different in pregnancy. The proportion of dermoid tumours, for example, is much greater than in the non-pregnant. According to Olshausen, they constitute about 3½ per cent of all cases, while in a series of 700 cases associated with pregnancy the tumour proved to be a simple or multilocular cyst in 477, a dermoid in 165, sarcomatous or carcinomatous in 40, and in 18 a fibroma or solid adenoma. Various reasons have been assigned for the disproportionate number of dermoid tumours; but whatever the explanation, the fact is important, as they form a more serious complication of pregnancy than the ordinary cystic forms, owing to their greater liability to cause inflammatory symptoms.

When associated, pregnancy and ovarian tumour react unfavourably on each other, and their reciprocal effects are of clinical importance. The presence of the tumour undoubtedly predisposes to premature interruption of the pregnancy, but this tendency has been much exaggerated. At any rate, it is exceptional for abortion to occur if the tumour itself escapes complications. In several cases, incarceration of the uterus has been caused by an ovarian tumour; while in the end of pregnancy the tumour, more particularly when large, may prevent the head from entering the pelvic brim. Even the largest tumours do not seem materially to interfere with the development of the fœtus. On the other hand, pregnancy predisposes in a marked degree to the various accidents to which ovarian tumours are liable. For example, torsion of the pedicle cyst, suppuration, and rupture are relatively much more frequent than apart from pregnancy. It is sometimes asserted that the growth of ovarian tumours is accelerated during gestation, but there is no evidence to show that pregnancy exercises any uniform influence in this direction. Still less do the facts support the view advanced by Wernich that pregnancy causes malignant degeneration in previously benign growths.

The symptoms to which an ovarian tumour gives rise in the course of pregnancy are extremely variable, and depend largely on the presence or absence of complications. In many cases there are no symptoms beyond those of pregnancy, and from first to last there may be nothing to suggest to the woman the existence of a dangerous complication. More often, however, a careful inquiry will elicit some unusual features. While there may be simply an exaggeration of one or other of the recognised symptoms, occasional attacks of pain, of longer or shorter duration, are frequently complained of in the region of the affected ovary. Disturbances of micturition are especially common in the early months; and, in the case of large tumours, we find evidences of mechanical distension in œdema of the legs or abdominal wall, in the disturbed digestive functions, or in an embarrassment of the respiration which may be so great as to demand speedy relief. But it is when complications of the tumour supervene that we get the most serious and characteristic symptoms. The clinical features of these are identical with the same attacks in the non-pregnant. Peritonitic attacks are especially common, and occurring during pregnancy should always suggest the possibility of ovarian disease.

The recognition of an ovarian tumour during pregnancy presents, as a rule, no great difficulty, and must rest on the usual physical signs. On inspection a double tumour will often be observed, and this will be readily confirmed by palpation and bimanual examination. It is where the tumour is very large that the difficulties are greatest. The abdominal signs of pregnancy may then be entirely obscured; and even within a few weeks of term it may be impossible to feel the fœtal parts or to hear the fœtal heart sounds. It will often be possible, however, to make out the characteristic uterine contractions. An important aid to diagnosis is to be found in the method employed by Schroeder. During bimanual examination he fixes the cervix uteri with a volsellum, which is manipulated by an assistant, and thus helps in the differentiation of the two tumours.

Many mistakes in the diagnosis of this complication have been made from not attaching sufficient weight to the signs and symptoms of pregnancy which were present. In a patient with ovarian tumour suppression of menstruation should always suggest pregnancy. In the absence of abdominal signs the various symptoms, and the vaginal signs, more especially the characteristic changes in the cervix, have an increased importance.

The association of pregnancy with an ovarian tumour will always be a cause for anxiety. Though many cases pass through pregnancy and the puerperal period without accident or even without inconvenience, experience shows that this is exceptional, and that "there is no security against some formidable catastrophe." In a large series of cases collected by the writer the maternal mortality was nearly 20 per cent, and even this would have been much higher but for operation undertaken on the development of urgent symptoms. The danger lies in the possibility of complications; and these may be anticipated, in more or less severe form, during pregnancy or the puerperal period in nearly every second case. The most common complication of the tumour is torsion of its pedicle, which is met with in over 12 per cent of the cases.

Treatment.—Within recent years the treatment of ovarian disease in pregnancy has undergone great change. Till lately it was the practice to avoid interference in the absence of any urgent symptom; and where remedial measures were demanded, either to aspirate the tumour or to induce premature labour. These methods are now discarded or reserved for exceptional cases; and it is generally held that the best treatment, when an ovarian tumour is found to complicate pregnancy, is immediate ovariotomy. It can be shown that ovariotomy gives better immediate results, for mother and child as well, than either non-interference or aspiration of the cyst, while at the same time it relieves the woman of her disease. Though occasionally it may be more difficult, ovariotomy in pregnancy is in no way more hazardous than apart from pregnancy. The mortality in a large series of cases, including those fatal cases in which some complication of the tumour preceded operation, was only 3 per cent, while pregnancy remained undisturbed in over 70 per cent. The more recent cases show even better results.

There is a disposition among many, even of those who in general advocate ovariotomy, to make an exception in the case of small tumours, which they believe may be safely treated expectantly, but it should be noted that dangerous complications are quite as frequent in the small tumours as in those of larger size.

As to the time at which ovariotomy may be most safely performed, Dsirne concluded, from an analysis of 135 cases, that the second, third, and fourth months gave the best results for the mother, and the third and fourth months for the child. A larger survey shows that the operation may be performed with almost equal safety for mother and child at any period of gestation. There is, in fact, no elective period for ovariotomy in pregnancy. Whenever an ovarian tumour is detected during pregnancy, no matter how small, the rule should be to advise its immediate removal.

Affections and Complications other than those of the Generative Organs

Disorders of—

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- Digestive and Sympathetic . 51
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See also Eclampsia; Chorea; Pregnancy, Insanity of.

The affections and accidental complications of pregnancy will naturally include: (A) those which can be distinctly traced to the presence of the gestation, and which may be one of three classes: (α) Direct results of sympathetic irritation, as sickness; neuroses, or pathological exaggerations of the physiological conditions of pregnancy; (β) Mechanical results of pressure, as from some uterine displacement; (γ) Complex, *i.e.* partly neurotic, partly mechanical, and partly obscure nutrition changes produced by the pregnant state.

(B) Those which may arise apart from pregnancy or are grafted upon or are independent of it, but which seriously interfere in many cases with its normal course, *e.g.* the specific fevers.

It is obviously impossible to classify each symptom or disease under one of the above headings, and it has been deemed preferable to give them in detail under the various "systems" involved.

I. The Nervous System.—Pregnancy intensifies the susceptibility of the nervous system; all parts of it are liable to be affected. Thus, in considering the special senses we may meet with amblyopia (apart from nephritis), hemeralopia, deafness, perversion of taste and smell, and loss of one or both. In the psychic state we meet with uncertainty of temper, melancholia, and insomnia. The motor tracts are rarely involved. Among vaso-motor disturbances there occur neuralgias, vertigo, syncope, local anæsthesia, paresis. There are also the reflex symptoms of hiccough and cough. All of these complications are as a rule less noticeable during the second half of pregnancy than during the earlier portion. *Locomotor ataxy, progressive muscular atrophy,* and *general paralysis of the insane* may occasionally complicate pregnancy, but so far as can be ascertained from the few cases reported nothing abnormal in the course of the gestation has been observed.

Convulsions may be due to epilepsy, hysteria, or albuminuria (see "ECLAMPSIA" and "NEPHRITIS"). Epileptic seizures are not attended by any interference with the course of pregnancy. It is said that the fits may arise for the first time during this condition, but this is doubtful; there is no albuminuria.

Among the more important instances of *paralyses* are paraplegia, hemiplegia, and paralysis of the face and of the nerves of special sense. Many of these are complicated by albuminuria. Under these conditions it is generally advisable, if the albumin does not disappear with ordinary treatment, to induce labour. On the other hand, all of them may be due to affections unaccompanied by albuminuria, such as in cerebral and spinal hæmorrhages.

Chorea is a grave complication. In the majority of cases the disease existed during childhood or at puberty. It is usually bilateral. Primigravidæ appear to be much more frequently attacked than multiparæ. It does not, as a rule, complicate subsequent pregnancies. Buist places the mortality very high, one in five proving fatal. In addition to this there is certainly a tendency to a permanent resulting disturbance. None of the usual drugs appear to have much effect in ameliorating the condition, and the obvious treatment in a large number of cases, especially if the movements are tending to increase, is artificial interruption of the pregnancy.

Tetany (tetanilla) is a tonic, usually painful spasm, beginning in and often limited to the muscles of the extremities, chiefly the hands. It is always symmetrical. No loss of consciousness has been observed. The attacks are "intermittent and of short duration (five to fifteen minutes)"; they may recur daily. The spasms are preceded by tingling or numbness in the parts presently to be affected, and the same sensations follow the relaxation of the spasm. It is commoner in delicate than in robust women. There is no pyrexia, and it may be looked upon as a slight ailment tending always to spontaneous recovery.

Tetanus is as rare as tetany. "The spasm begins in the muscles of the face and neck (trismus) and advances centrifugally, with opisthotonos." The spasm is constant, and subject to exacerbations. The temperature is usually raised, and the disease practically always terminates fatally. Robust patients are most frequently attacked. Both of these conditions must be diagnosed from hysteria and spinal meningitis.

II. DIGESTIVE AND SYMPATHETIC DISTURBANCES.—A certain amount of nausea and vomiting of a glairy, frothy material, especially in the early morning on first assuming the upright position, is the rule in the early months of pregnancy. The nausea has been compared to sea-sickness. This usually ceases as the uterus rises out of the pelvis, and remains absent for the remainder of the gestation period. In some cases the vomiting of at least one meal a day may persist throughout the nine months without any bad constitutional effect arising beyond slight wasting. Under certain conditions, fortunately rarely, graver symptoms arise, all nourishment is rejected, and as a consequence marked emaciation sets in, the aspect of the patient becomes pinched and anxious, the tongue dry and brown; the temperature and pulse gradually rise, and she may gradually pass into a state of delirium and die unless relieved by spontaneous abortion or artificial interruption of the pregnancy. This condition is usually called the "uncontrollable vomiting of pregnancy." Occasionally it is discovered that a retroverted incarcerated uterus is the cause of all the distress. Treatment of the minor cases of sickness is sufficiently simple. The patient should be directed to keep the bowels regular daily by means of a cascara and belladonna pill, to take simple and digestible food, and to drink a cup of tea and eat a rusk before rising in the morning. An effervescing mixture, with hydrocyanic acid, thrice daily is as a rule the only medical treatment required. If the vomiting, however, persists various other remedies have been suggested, such as oxalate of cerium (gr. v.) in pill three times daily, as recommended by Simpson, small doses of morphia, or hydrochlorate of cocaine. Should these fail it may be necessary to put the patient to bed and feed her entirely on nutrient enemata, the thirst being relieved by the sipping of hot water. In severe cases certain local applications have been applied to the cervix with considerable benefit. The author has been accustomed to apply a solution of cocaine or strong tincture of iodine through a speculum by means of a camel's hair brush. In some cases this has been followed by almost instantaneous relief, in others has absolutely failed. Should the uterus be retroverted and impacted it is best to draw off the urine, push the fundus above the pelvic brim, and support it there by means of a watch-spring ring pessary. Chapman recommends the application of spinal ice-bags in intractable cases, but no great success seems to have attended this method. Copeman advocated the dilatation of the cervix with the finger, and stated that he met with many favourable results from the adoption of this procedure. It is obvious, however, that it must only be resorted to with the greatest caution, as a miscarriage may easily be induced.

Should the vomiting persist in spite of the above-mentioned remedies, nothing remains but to procure abortion; this should not be too long delayed, and should only be carried out after the practitioner's opinion has been fortified by another authority. The introduction of one or more laminaria tents is the better plan, although the completion of the operation at one sitting by means of Hegar's dilators and the curette has been strongly advocated by many obstetricians. Unfortunately, even this does not always save the patient, more especially if interference has been unnecessarily delayed.

Minor forms of digestive disturbance which may be mentioned are capricious appetite (pregnancy longings), toothache, heartburn, and flatulence.

Constipation is the rule in the pregnant woman, more especially in the earlier months if the patient is naturally of a constipated habit; it is probably due to interference with the venous circulation and interchange of fluids, later to pressure of the uterus. Unless great care be adopted the colon may become filled with hard scybala, which may remain there throughout the pregnancy, and only give rise to trouble after parturition has taken place Purgation produces a diarrhœa which may easily deceive both practitioner and patient without evacuating the contents of the distended colon.

Ptyalism is a very distressing complication, and although, as a rule, the flow of saliva is not excessive, in some marked cases it may amount to at least a quart in the twenty-four hours. The patient may find it necessary to spend her time catching the saliva which flows from her mouth into a bowl. The salivary glands are often enlarged and tender. No remedy but the termination of pregnancy seems to be of any avail, but astringent gargles with counter-irritation over the parotid areas may be tried.

Jaundice (icterus) may be due (*a*) to catarrh of the bile-ducts; (*b*) to acute yellow atrophy; (*c*) malignant disease. Icterus should always be looked upon with a certain amount of apprehension when complicating pregnancy, and, so long as it runs the usual course, no special treatment is necessary; should it, however, persist, the patient may be the subject of acute atrophy or possibly malignant disease. The former consists in "poisoning of the system by an accumulation of bile-acids in the blood, together with secondary degeneration of the parenchyma of the great glands and of the substance of the muscles, especially of the heart." A diagnosis must, of course, be made from acute phosphorus poisoning. The prognosis is very grave as regards both mother and the fœtus. The question of induction of abortion should usually be decided in the negative. Carcinoma is only recognised with difficulty during pregnancy, but it is quite obvious after the uterus has been emptied of its contents. Induction of premature labour may be necessary to relieve the intense pain which frequently accompanies this condition.

Diabetes as a disorder of the hepatic glycogenic function has been inserted here; it must not be confused with physiological glycosuria, which is frequently present in normal pregnancies. It is, fortunately, a rare condition, and we owe to Matthews Duncan any knowledge there is on the subject. He reported twenty-two cases, of which four ended fatally during the puerperium from collapse or coma. He concludes from his researches into the histories of published cases that diabetes may come on during pregnancy, and that it may cease with the termination of that condition. Diabetics are not necessarily sterile, but pregnancy is very liable to be interrupted in its course, and nearly always in consequence of fœtal death.

Diabetes insipidus has been noted in many cases of pregnancy. The amount of urine passed may reach as much as 300 ounces in 24 hours. It appears to set in about the fifth or sixth month, and to disappear entirely after labour.

III. Cardio-vascular Disturbances.—During pregnancy the work of the heart is augmented owing to the larger quantity of blood and the increased resistance in its circulation. During the later months this task is added to in consequence of the decreased power of expansion of the thorax and the compression of the large abdominal veins by the pregnant uterus. In spite of this additional work, a healthy heart is possessed of so much reserve force that hypertrophy is unnecessary. Larcher affirms that in all cases of pregnancy there is hypertrophy of the left ventricle. Should the balance between the heart's beat and the increased amount of blood be disturbed we meet with such complications as palpitation, temporary vertigo, faintness, and dyspnœa: these need give rise to no anxiety provided the heart muscle and valves are sound.

The pregnant woman may be the subject of several *forms of cardiac lesion.* They are: (1) Adhesions from former pericarditis, among which would be included those in which the heart has been displaced by pleural adhesions; (2) Myocarditis and degeneration of the cardiac muscle; (3) Endocarditis, chiefly affecting the valves (valvular heart disease); and (4) Acute endocarditis grafted upon the chronic form. It is important to bear in mind that valvular disease is not the only form of cardiac disorder which may give trouble: all the above-mentioned conditions may produce much distress and danger when complicating pregnancy, and it is frequently less often owing to a disturbed valvular mechanism than to a loss of reserve force of the heart that the so-called compensatory disturbances arise. When compensation becomes insufficient during pregnancy certain phenomena occur in greater or less severity: these are varicosities of the legs and labia, œdema of the feet, legs, and vulva, or even general anasarca, palpitation, and syncope, irritable cough, bronchitis with dyspnœa and cyanosis, hæmoptysis, albuminuria, and, lastly, serous effusions into the peritoneal and pleural cavities. Aortic stenosis is certainly the most dangerous form of valvular lesion; but many women with marked mitral lesions may go through pregnancy and labour without untoward symptoms arising, provided compensation be present. Abortion and premature labour occur frequently, and it is proved by statistics that fatal results are nearly twice as frequent in cardiopathic multiparæ as in primigravidæ.

Treatment in mild cases should be confined to the avoidance of over-fatigue, too much stair-work, and the regulation of the bowels, straining at stool being especially avoided. Compensatory disturbances may appear as early as the ninth week of pregnancy, though as a rule not until the fifth month. Should albuminuria set in it must be looked upon as a serious phenomenon.

As a rule a mixture of liquor arsenicalis, ♏v., and liquor ferri dialysati ♏x., or liquor strychniæ ♏v. thrice daily, will counteract the anæmia and want of tone in these cases; a stimulating mixture of ether and ammonia will be useful to cope with the attacks of syncope.

Should marked œdema or effusion set in with dyspnœa, the exhibition of digitalis in the form of tincture or infusion will be indicated, more especially where the lesion is valvular and of the mitral variety; it is contra-indicated in aortic disease. Tincture of strophanthus (♏iii.-♏x.) is in some cases an extremely valuable heart tonic, but its administration is also not advisable in aortic stenosis. Treatment by induction of abortion may be attended by very grave results. Schlager reports three cases in which he resorted to induction of premature labour, all of which terminated fatally. We must consider that the condition of any patient in which it is thought necessary is one of extreme gravity, and the mere fact of interrupting the pregnancy will not stay the cardiac degeneration which is going on.

Varicose veins are most often observed in multiparæ, although they are not uncommon in primigravidæ. They may be capillary in form, "in which case an arborescent network of bluish vessels is seen round the ankles, and especially on the inner surface of the thighs." The deep veins lying below the point of division of the iliac veins are also involved, as is shown by the constant occurrence of hæmorrhoids and vulval varicocele. The left limb is affected more than the right, and more towards the latter end of pregnancy.

The chief danger in connection with these varicosities is the possibility of *thrombosis and embolism.* Spiegelberg has seen four fatal cases of this kind. Another danger is that by ulceration or traumatism one of the veins may rupture and profuse hæmorrhage follow. This is especially the case in the vulva, where the accidental rupture of a plexus by a broken utensil has been known to lead to fatal bleeding.

Hæmorrhoids are probably the most frequent and distressing complications of advanced pregnancy; treatment should be upon the same lines as in the non-gravid state, and requires no further notice here.

Thyroid enlargement is very usual to a slight extent, and was observed by ancient writers; it is, as a rule, a purely vascular change, and unless there is a true goitre present, disappears after the termination of the pregnancy.

IV. Blood Changes.—The blood-mass or actual quantity of blood is markedly increased during gestation, and more especially in the later months, producing a spurious plethora. Its composition is, however, very radically changed, and becomes more watery, the albumin is deficient in the serum, and the red corpuscles are diminished in number. In addition to this the fibrinous element is much increased, as are urea and extractives, especially after the sixth month. Hence the blood condition is really one of anæmia rather than plethora. It has been shown by Willcocks that the blood of pregnancy differs from chlorosis in that the individual blood cells are not impoverished in the former, "but are lessened in comparative number owing to an increase in the water of the plasma, the result of the progressive enlargement of the vascular area during pregnancy." In both conditions the hæmoglobin is lessened.

This watery state of the blood may be much exaggerated under certain circumstances, giving rise to what is called (α) *hydræmia* or serous plethora; it consists of serous effusion into the cellular tissue and peritoneal, pleural, and pericardial cavities. The œdema may occasionally form very rapidly, and, if in the thorax, is attended by great danger. The lower extremities are also frequently affected, but the face, as a rule, remains free, and there is no albumin. This œdema must be carefully distinguished from the ordinary puffiness of the feet and legs which is so frequent in the later months of normal pregnancy.

(β) The second type to which this poverty of blood may lead is *progressive pernicious anæmia.* In this condition too few red corpuscles are produced, and too many shrunken and ill-developed ones are thrown into the circulation. Fatty degeneration of the heart, especially of the papillæ, follows, and a somewhat similar change in the minor coats of the arteries and capillaries. The disease begins very insidiously during the early months, but the graver symptoms do not manifest themselves until later; the prognosis is extremely grave. Of Graefe's twenty-five cases almost all died. Abortion frequently occurs; induction of labour is absolutely indicated, and as early as a diagnosis is made. Transfusion has been tried, but has been so far attended by uniformly fatal results. The treatment of extreme cases of anæmia must be dietetic and medicinal. The diet should be easily assimilated, and consists of milk, eggs, and beef tea, while iron in all forms and combined with arsenic or phosphorus is strongly indicated.

Purpura hæmorrhagica is defined by Immermann as an acquired and transitional diathesis which suddenly and unexpectedly, and always sporadically, occurs in persons who have been apparently quite healthy, and which cannot be traced to family taint or history as in hæmophilia. The prognosis is extremely serious when complicating pregnancy, the large majority proving fatal. Abortion or premature labour almost inevitably takes place, but at variable periods, either owing to the serious general disturbance or to hæmorrhage into the placenta. The disease is not transmitted, so far as has been observed, to the fœtus; it is certainly one of the causes of intra-uterine death.

V. Syphilis.—If infection be recent this disease is followed by the usual primary symptoms; the secondary and tertiary signs are usually of a mild type, probably due to the more active processes of nutrition in the pregnant condition.

Constitutional syphilis has a very injurious influence on the fœtus; intra-uterine death may occur, followed by abortion, or if the child is born alive it is either premature or very weakly, and may die early. Should it appear healthy at birth congenital symptoms speedily set in, taking the form of marasmus, nasal ozæna, corneitis, rashes, and characteristic dentition.

The placenta may be affected in two ways: either a general fibrosis may invade its substance, or distinct gummata may be formed.

A woman who has given birth to a syphilitic child may, according to Colles, expose herself to infection by suckling it or otherwise without risk.

Treatment during pregnancy should always be systematically carried out. Mercury and iron, combined with a little opium, being given in the form of pill thrice daily throughout the gestation period.

VI. Pulmonary Disturbances.—There seems to be a slight increase in the amount of carbonic acid discharged from the lungs during pregnancy. During the later months there is a diminution in the vital capacity of the lungs, the thorax being increased in breadth, but diminished in its antero-posterior diameters—this being exactly reversed after the termination of labour. The changes are due probably "to the diaphragmatic points of insertion being pulled upon by the descending uterus; the base of the thorax yields at its weakest spot, *i.e.* the anterior wall, the flexible costal cartilage being attached there." The result of this is that the sternum recedes, thus reducing the antero-posterior thoracic diameter, while the ribs become increased in their lateral curves. These physical changes will account for the feeling of oppression felt by the patient towards the end of pregnancy, and the relief obtained by the "lightening before labour" when the uterus sinks deeply into the pelvic brim.

Among acute pulmonary diseases *pneumonia*, although extremely rare in the pregnant woman, is markedly fatal. The gestation may be interrupted, but this is more likely to occur in the later months; this is probably due to the incomplete aeration of the maternal blood, and partly to the death of the fœtus, which is the result of the high temperature. Double pneumonia is always fatal, and septic processes are found to be much more frequent sequels to labour than in normal cases. Induction of premature labour is contra-indicated, all treatment being directed to the pulmonary lesion.

Phthisis does not necessarily lead to sterility; the effect of pregnancy upon this lesion was formerly thought to be favourable, but at present the reverse seems to be the generally accepted opinion. As to whether this condition favours the growth of tubercle or not is a little undecided. Treatment by artificial abortion is strongly contra-indicated, and the induction of premature labour is only admissible when the enlarged uterus interferes mechanically with the expansion of the lungs.

Bronchitis of the chronic type leads to much dyspnœa and distress during pregnancy, and the engorgement of the right heart may become so marked that venesection or leeching may be necessary; it is frequently followed by great and immediate relief.

Pleurisy leading to effusion or empyæma must be treated after the same methods, surgical and otherwise, as would be followed if the disease attacked the unimpregnated female. (See "Pleura.")

VII. Renal Affections.—In the kidneys of the pregnant woman hyperæmia and increased epithelial proliferation are found, and cannot be attributed to the result of the pressure of the enlarged uterus. The urine is somewhat altered; it may be acid, rarely alkaline. As pregnancy advances, phosphates, sulphates, urea, and uric acid decrease, while water and chlorides increase; the marked watery condition of the urine is due to increased arterial tension. To this latter factor the presence of transient or permanent albuminuria is due. There seems little doubt that vesical hæmorrhage or catarrh of the mucous membrane may occur, leading to a temporary appearance of albumin. This condition always causes anxiety, and the urine should be carefully examined at regular intervals throughout the pregnancy.

Albuminuria is present in a large number of cases of puerperal eclampsia, and also in certain forms of paralysis of the special nerves (amaurosis), or of the spinal system; it may also occur in puerperal mania. (See "Pregnancy, Insanity of," p. 172.)

The presence of albumin to a small extent is found in a considerable proportion of pregnant women (2 to 4 per cent), but it usually rapidly disappears after labour, which may be concluded without any untoward symptoms arising. Care must be taken to distinguish between the patient who is the subject of chronic renal disease and the one in whom the albumin has appeared for the first time during pregnancy.

The causation of this complication is still the subject of much discussion; but there are four theories which should be considered, none of which, however, seem to be entirely adequate: (1) Pressure on the venous renal vessels by the uterus: this view is favoured by the fact that albumin rarely appears until after the fifth month of pregnancy, and is much more common in primigravidæ, owing probably to the resistance of the abdominal parietes being greater. On the other hand, the albumin appears long before the uterus is large enough to exert any pressure upon the renal veins, and large growths (fibro-myomata and ovarian cytomata) do not always lead to this condition; there must obviously be something in addition to the uterine pressure. (2) That the ureters are obstructed or at least narrowed by the pressure of the gravid uterus. This has been proved by experiment to be untenable, and no constant dilatation of the pelvis of the kidney nor of the ureters themselves has ever been observed. (3) That it is due to the increased work thrown upon the kidneys by the addition to the blood of the fœtal waste products. (4) That too much stress has been laid upon the mechanical causation, and that the process is rather due to the presence of some toxic material in the blood (Clifford Allbutt).

If the albuminuria is recent symptoms as a rule do not show themselves before the seventh month; they may then come on very suddenly—persistent headache, vertigo, diplopia, vomiting, and slight œdema of the face, hands, and feet. A working-woman will often complain of inability to thread her needle. The albuminuric deposit consists of para-globulin; in chronic cases the deposit is mainly serum-albumin. Various paralyses may arise, and well-defined ocular changes (see "Nephritis"); œdema of the lungs may also set in. There will be a decided tendency to hæmorrhages and to abortion, which latter is owing to the death of the fœtus; it may be expelled or be retained in a macerated condition. Fœtal death is probably due to imperfect nutrition or to changes in composition of the maternal blood. Eclampsia is more likely to occur in recent cases, while ocular changes are usually present in the more chronic forms.

Treatment varies according to the period at which the albuminuria first appears. When it begins early the object of the practitioner should be to promote an increased secretion of urine, and to produce diaphoresis and purgation. Saline diuretics, such as acetate and citrate of potash, fulfil the first requirement, while watery motions will result from daily administration of compound jalap powder. The hot air bath or warm wet pack produce copious sweating and are of great assistance. The patient's urine should be examined every week, and if, in spite of the above remedies and a milk diet, the albumin still increases, absolute rest in bed must be enforced. By some authors milk diet is prescribed, the milk being skimmed. Should these measures fail, the question of induction of abortion must be seriously considered. It is in itself attended by the risk of bringing on an eclamptic attack; but considering the matter from all points, and if severe headache and dizziness are present, there is no doubt of the propriety of performing it. The operation may be carried out by means of tents, or at one sitting under an anæsthetic.

If the albumin appears late in the progress of gestation active measures are at once necessary—free purgation, administration of chloral and bromide of potash, and everything prepared for the induction of premature labour. (See "Eclampsia," vol. iii.)

VIII. Cutaneous Rashes.—*Anomalous pigmentation* consists of the deposit of a brownish pigment in various sites on the skin, especially the face, areolæ, and external genitalia. The forehead is covered with dark, irregular patches more marked near the roots of the hair; dark rings appear round the eyes and occasionally round the root of the nose and the mouth (pregnancy mask). In cicatricial tissue the pigmentation is often very marked. Similar staining is found about the navel and the umbilico-pubic line. The thenar and hypothenar eminences may become stained a deep pink colour immediately pregnancy commences; this variety disappears immediately after labour, but a slight amount of pigmentation is always permanent to some extent

Herpes gestationis usually begins in the form of clusters of vesicles on the vulva or on the extremities, and may spread over the whole body. The rash persists as a rule throughout the pregnancy, and disappears spontaneously after delivery, returning with a fresh conception. The treatment is exactly as in the non-gravid condition.

Impetigo herpetiformis appears as small pustules on the inner side of the thighs. They spread rapidly and may involve the scalp. Much constitutional effect is produced, and the disease may even run a fatal course. (See "Dermatitis," vol. ii. p. 460.)

Pruritus, or itching, may affect the vulva only or the whole of the body surface. It may become so intense, and produce such constitutional disturbance as to lead to a consideration of induction of premature labour.

It is usually a neurosis, but may be due to eczema or intertrigo. The best modes of treatment are purgation and the administration of the bromides, with local cleanliness and the application of lotio nigra or a solution of hydrochlorate of cocaine. Sitting in a hot bath containing boracic acid just before going to bed is often a very effectual remedy.

IX. Specific Fevers.—It was formerly believed that the pregnant woman was protected or immune from the specific fevers, and that the pregnant condition had a curative effect on others; this has been proved to be entirely erroneous.

Many of the fevers when complicating pregnancy may run an unaltered course, or may produce grave complications. Abortion often results from the high temperature, or from the effect of the diseased maternal blood upon the epithelium of the fœtal placenta. The fœtus may be born with the rash fully out upon it. It is said that the child born of a woman suffering from a specific fever may in some instances be immune from that particular variety.

(*a*) *Variola.*—this is the most frequently observed among the exanthemata attacking the pregnant woman; it is attended by extreme danger, owing to the liability of the patient to the hæmorrhagic variety; premature labour and abortion are hence very common, and severe uterine hæmorrhage frequent. A peculiar clinical fact has been noted, that in small-pox epidemics many women will abort with much hæmorrhage without the rash appearing. It is always advisable to vaccinate a pregnant woman if she is liable to be brought into contact with this disease. The mortality in the severer forms is at least 90 per cent, while in the milder epidemics about 10 per cent. (*b*) *Enterica* (typhoid) is said to be more frequent during the earlier months of pregnancy than later; abortion and premature labour occur in nearly 70 per cent. The higher the temperature the greater the risk of abortion. The use of cold baths to reduce the fever certainly conduces to a premature interruption of pregnancy. The prognosis is good in mild cases occurring early in gestation, but more grave in the later months and after a continuance of pyrexia. The treatment cannot in any way be modified from that pursued in the non-pregnant state. (*c*) *Scarlatina* is more frequent after delivery than during the pregnant condition, leading to the supposition that the patient may to some extent be immune. (*d*) *Morbilli*, unless of a very grave type, runs a normal course and without affecting mother or child. (*e*) *Erysipelas* is dangerous from the probabilities of post-partum infection taking place, and acute septic disease setting in indistinguishable from puerperal septicæmia. (*f*) *Continued fevers* may attack the pregnant woman, and from the pyrexia lead to abortion.

X. OSSEOUS CHANGES—Osteophytes are small bony deposits which form on the inner tube of the cranial vault, and chiefly on the frontal and parietal bones. They mainly lie along the groove of the middle meningeal artery. It is said that they are, however, not entirely confined to the pregnant condition. (See also "PREGNANCY, PHYSIOLOGY OF," vol. ix. p. 499.)

Osteo-malacia (malacosteon) is an extremely rare complication of pregnancy in the British Isles, but is common in Germany and Austria. This disease may be defined as a degeneration of the bones, chiefly of the pelvis and spine, resulting in the loss of lime salts, and consequently a softening: it is entirely dependent upon the pregnant state. No treatment seems of much avail while the pregnancy goes on, except the removal of the ovaries and tubes with or without the pregnant uterus (Porro's operation). Should the disease continue after labour has terminated, oöphorectomy is advisable and is usually successful.

XI. VESICAL COMPLICATIONS.—The bladder becomes more irritable, the desire to micturate more frequently setting in soon after pregnancy commences; this is probably due to the anteversion which occurs at this period. This labour may go on until labour is terminated. Incontinence and absolute retention may result from pressure of the cervix on the neck of the bladder with an impacted retroverted uterus. This latter complication, which is not infrequently attended by a dribbling (overflow from much distension), is relieved in milder cases by the passage of the catheter; the uterus then gradually rises above the pelvic brim, and all danger is at an end. In more severe cases an anæsthetic is necessary, and manual reposition of the displaced uterus necessary, the left hand being passed into the vagina, or two fingers into the rectum; a stiff ring pessary should be inserted to keep the fundus in its place. Under very rare circumstances puncture of the fundus uteri per vaginam by means of a trochar is necessary; the liquor amnii escapes, and the uterus being reduced in bulk can then be pushed up out of the pelvis—abortion, of course, being the inevitable consequence.

Cystocele, or prolapse of the anterior vaginal and posterior bladder walls, becomes more troublesome during pregnancy, owing to the increased congestion of the mucous membrane, and therefore slightly more protrusion at the vulval orifice. (See also "BLADDER, DISEASES OF," vol. i. p. 480; and "CATHETER AND SEPTIC INFECTION OF THE URINARY TRACT," vol. ii.)

XII. MENTAL COMPLICATIONS.—Insanity of pregnancy is much less common than that attacking the puerperal or nursing woman (about 12 per cent). Many women are naturally despondent and low-spirited during gestation, and the form of insanity usually observed is that of melancholia. It affects primigravidæ more frequently than multiparæ, and is commoner in women between thirty and forty years of age than in younger ones.

Hereditary taint is a very important cause, as also are epilepsy and alcoholism in one or both parents. The disease may begin with conception, or more usually about the third or fourth month, and may recur with each successive pregnancy. The tendency is usually suicidal, but may be homicidal, or rarely a disposition to kleptomania. The prognosis is favourable, and the disease frequently disappears after labour. In bad cases the question of induction of abortion may have to be considered. In all such cases the patient should not be left alone, but should have a cheerful, firm nurse in constant attendance upon her. Change of scene without excitement is of the first importance.

(See also "Pregnancy, Insanity of," p. 172.)

Causes of Death during Pregnancy

These may be divided into three groups—(1) Where death is due to some cause which is not connected with the pregnant state; (2) where death is a consequence or result of pregnancy; (3) where a pathological condition existed before the onset of or developed during pregnancy, and which has been so aggravated by that state as to result in the patient's death. The first group requires no further consideration here, as it belongs to the domain of general medicine and surgery. Under the second heading two types require consideration; in one where death results from a normal, in the other from an abnormal, pregnancy. Normal pregnancy of itself very rarely causes death during its course, but it may under the following conditions:—Excessive vomiting, which is frequently associated with some pathological condition such as hydramnios, myxomatous degeneration of the chorion, albuminuria, etc., may occur without any such accompaniments, and, if allowed to continue, may lead to fever, syncope, delirium, coma, and, finally, to the death of the patient. Chorea sometimes develops during pregnancy, and, it is said, causes a mortality of about one in five cases. Spontaneous rupture of an apparently healthy uterus has been recorded as a cause of death. The development of varicose veins in the legs, pudenda, and pelvis as a result of pressure from the growing uterus is frequently met with. Phlebitis may follow, and death due to the clotting of blood in the pulmonary artery and its branches (1). Again, rupture of varicose veins of the legs or vulva has produced such profuse hæmorrhage in some cases as to kill the patients. Pregnancy sometimes so profoundly affects the blood as to lead to hydræmia or serous plethora, or to pernicious anæmia. Œdema of the lungs may occur in the former condition with a fatal result. Prognosis in pernicious anæmia is very serious. Eclampsia is one of the commonest causes of death during pregnancy, but this has been fully treated of under its appropriate heading. Acute yellow atrophy has a curious relationship to pregnancy, and terminates fatally practically in all cases within six days. Lastly, death may result from manipulations, as in a case recorded by Hektoen (2), where air was admitted into the uterine veins from the improper administration of a vaginal douche, and in cases of procured abortion from sepsis. In abnormal pregnancies deaths are more frequently met with, and of all causes rupture of an ectopic gestation is the commonest, the fatal termination being produced by shock and large intraperitoneal hæmorrhages. Myxoma of the chorion may produce a similar catastrophe, either by causing perforation of the uterus or hyperemesis gravidarum. The latter may also be a sequela of hydramnios. Retroversion of the gravid uterus, if not rectified by nature or the obstetrician, may lead to sloughing of the bladder or other pelvic viscera, or to uræmia, and in either condition death of the patient may result. As to cases where a pathological condition existed before the onset of, or developed during pregnancy, and which has been so aggravated by that state as to result in the patient's death, little need be said here, as the subject has been dealt with fully in the preceding pages. Of all pre-existing conditions heart diseases, whether of the valves or the myocardium, are most unfavourably influenced by pregnancy. This holds specially true in cases of mitral stenosis and aortic incompetence, though even in these cases a fatal termination is much more common during labour than during pregnancy.

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Hæmorrhage

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See also Labour, Post-Partum Hæmorrhage.

ANTEPARTUM HÆMORRHAGES

Arising as a Result of the Pregnancy

Antepartum hæmorrhages arising as a direct result of the pregnancy may be divided into three main groups :—

A. Hæmorrhages occurring during the first three months of pregnancy.

B. Hæmorrhages occurring during the second three months of pregnancy.

C. Hæmorrhages occurring during the last four months.

In adopting this classification, pregnancy is considered as the duration of ten lunar months of four weeks each. The first group includes hæmorrhages occurring before the full formation of the placenta. The second group includes hæmorrhages occurring from the time the placenta is formed to the time the fœtus becomes viable. And the last group includes hæmorrhages occurring after the fœtus is viable.

A. HÆMORRHAGES OCCURRING DURING THE FIRST THREE MONTHS

The hæmorrhages of the first three months of pregnancy, which arise as a direct result of the pregnancy, have three chief causes :—

(1) Abortion.—Abortion is the term applied to the expulsion of the

ovum from the uterus before the full formation of the placenta, that is before the end of the third month. It is a process which is of necessity accompanied by hæmorrhage, as it implies the rupture of the vascular adhesions which connect almost the entire surface of the ovum with the decidua. The varieties, or perhaps it would be more correct to say the phases, of abortion are as follows:—

(*a*) *Threatened abortion, i.e.* the onset of pain, hæmorrhage, and a varying degree of dilatation of the cervix occurring in a patient during the first three months of pregnancy.

(*b*) *Cervical abortion, i.e.* the condition which occurs when the ovum is expelled into the cervical canal, in which it becomes incarcerated as a result of the failure of the external os to dilate.

(*c*) *Missed abortion, i.e.* the retention of the ovum in the uterine cavity after its death has occurred.

(*d*) *Complete abortion, i.e.* the expulsion of the entire ovum.

(*e*) *Incomplete abortion, i.e.* the expulsion of a part of the ovum, the remainder being retained in the uterus. (See "ABORTION," vol. i.)

(2) ECTOPIC GESTATION.—Ectopic gestation, or extra-uterine pregnancy, is the term applied to the development of the ovum outside the cavity of the uterus. Such development may take place primarily in either the tube or ovary, but practically it always occurs in the former. As a hæmorrhage-producing factor, it is met with in two phases during the first three months—

(*a*) *Before primary rupture of the gestation sac, i.e.* while the ovum is still contained in the intact tube or ovary, as the case may be.

(*b*) *At the time of primary rupture of the gestation sac*, an event which occurs as a rule between the sixth and tenth weeks. (See "ECTOPIC GESTATION," vol. iii.)

(3) MYXOMA CHORII.—Myxoma chorii, or hydatidiform mole, is the term applied to a myxomatous degeneration which attacks the chorionic villi in certain cases. As a result, the villi become changed into cysts varying in size from that of a pin's head to that of a grape. If, as usually happens, the greater part of the ovum is affected by this change, the fœtus dies and is absorbed. If, however, only a small part of the ovum is diseased, the fœtus may continue to develop. The myxomatous change always commences before the end of the third month, that is before the disappearance of the chorionic villi. However, hæmorrhagic discharges may occur not only during this period, but as long as the uterus remains unemptied, and accordingly it must be set down as a cause of hæmorrhage not only during the first three months, but also during the second three. It will be most convenient, however, to refer to it under the former period only.

The above are the three causes of hæmorrhage during this period. Inasmuch as each of them are fully treated in the articles "ABORTION," "ECTOPIC GESTATION," and "MOLES," the writer will here confine himself to a brief account of the method of distinguishing between them.

In order to recognise the cause of hæmorrhage in any case the following points must be ascertained:—

(1) The existence of pregnancy.
(2) The duration of pregnancy.
(3) The present size of the uterus, and the nature of any alterations which may take place in it from day to day.
(4) The condition of the adnexa.
(5) The nature and duration of the discharge.

(6) The nature of any solid matter which may have been expelled from the uterus.
(7) The condition of the cervix.
(8) The symptoms of the patient.

(1) *The Existence of Pregnancy.*—The existence of pregnancy is the first point to be decided. This can be done by determining the presence of its usual subjective and objective symptoms.

(2) *The Duration of Pregnancy.*—The duration of pregnancy must be first ascertained as far as possible by the patient's history, without taking the size of the uterus into consideration. This is an important point to remember, as in some cases the diagnosis of the nature of the case will be largely based upon the difference between the actual size of the uterus and the size it ought to be in accordance with the period of pregnancy.

(3) *The present Size of the Uterus and the Nature of the Alterations which take place in it from Day to Day.*—The present size of the uterus is a considerable aid to diagnosis in cases of hæmorrhage, when it is taken in connection with the supposed date of pregnancy. If the uterus corresponds in size with the duration of pregnancy, it is strong evidence for supposing that it contains a living ovum, or one which has only quite recently died. If, however, the uterus is larger than the period of pregnancy accounts for, the possibility of myxoma chorii must be thought of. If, again, the uterus is smaller than the period of pregnancy would lead us to suppose it ought to be, it suggests, first, that perhaps the pregnancy is extra-uterine, and, secondly, if that supposition is proved to be erroneous, that the ovum is probably dead.

The alteration in size of the uterus from day to day is also important. If it increases at the natural rate, it is almost conclusive evidence that the ovum is intra-uterine and living. The only other condition under which this rate of increase could occur is in the case of a missed abortion, in which just sufficient intra-uterine hæmorrhage is taking place each day to cause the same rate of increase that a growing ovum would cause. Such a state of affairs is necessarily so rare that in practice it may be neglected. If the uterus ceases to increase in size, or even commences to become smaller, it is equally strong evidence that the ovum is dead, that is, that a condition of missed abortion is present. If the uterus grows more rapidly than is normal, it is strongly in favour of myxoma chorii.

(4) *The Condition of the Adnexa.*—The condition of the adnexa is of importance, if the question of the possibility of the existence of an extra-uterine pregnancy arises. If they are normal in size on both sides, the possibility of extra-uterine pregnancy is immediately eliminated. The typical condition met with in extra-uterine pregnancy prior to the rupture of the sac is as follows:—A globular or ovoid tumour, varying in size from a pullet's egg to an orange, is found at one or other side, corresponding in position to the tube of the same side. The tumour is elastic to touch, and slight pulsation may be felt in it owing to the increased size of the vessels which supply it. The uterus, which is also somewhat enlarged, is displaced towards the opposite side by the tumour. If rupture has occurred, it may be possible to determine the disappearance of a tumour whose existence had been previously ascertained, and the gradual formation of another tumour in Douglas' pouch.

The physical signs which help to distinguish between an unruptured tubal pregnancy and any other tumour of the adnexa are:—

(*a*) In tubal pregnancy the enlargement corresponds to the position of a tube rather than of an ovary. Ovarian pregnancy is said to occur, but it is so rare that it may be neglected.

(*b*) An extra-uterine pregnancy is usually unilateral. Inflammatory disease of the tubes is almost always bilateral.

(*c*) The sac of a pregnancy pulsates, and occasionally contractions of its walls may be felt (Kelly).

(5) *The Nature and Duration of the Discharge.*—Slight hæmorrhagic discharge is not indicative of anything definite. It occurs in all forms of abortion, in extra-uterine pregnancy, and in myxoma chorii. Profuse hæmorrhage is conclusive evidence of some form of abortion, most probably threatened or incomplete. A profuse, watery, blood-stained discharge points strongly to myxoma chorii. If small cysts are found in it, it is pathognomonic of that condition. More or less profuse dark-coloured discharge shows that the ovum is dead, and that part or all of it is still retained in the uterus. Putrid discharge shows that the ovum is not only dead, but that decomposition has occurred. If the discharge quickly lessens, and after a few days disappears altogether, it may usually be taken to show either that the threatened expulsion of the ovum has passed off, or that the uterus has emptied itself, that is, that complete abortion has occurred.

(6) *The Nature of any Solid Matter which may have been expelled from the Uterus.*—It cannot be too strongly insisted upon, that, in the case of a patient who is bleeding, all matter which is expelled from the uterus must be most carefully examined. It is by so doing that, in the majority of cases, we obtain the necessary information to enable a diagnosis to be made. The expelled matter, if we can obtain it all, gives absolute information as to what has happened in the uterus, while the information obtained in other ways is generally more or less problematical. If an entire ovum is expelled, it is self-evident that complete abortion has taken place; or if only a portion, that the abortion is incomplete. In order to be absolutely certain that the case is one of abortion, either chorionic villi or some fragment of a fœtus must be found. A mere mass of decidua does not enable us at first sight to say whether the case is one of intra- or extra-uterine pregnancy; a microscopical examination of it will be necessary. Dakin states that the true decidua of an intra-uterine pregnancy is indistinguishable from the false decidua of extra-uterine pregnancy. However, in the former case some fragment of chorion or amnion will be found by the aid of the microscope, and this of course is pathognomonic. If intra-uterine pregnancy is excluded, the expulsion of a decidual cast of the uterus in the presence of a growing pelvic tumour is diagnostic of an extra-uterine pregnancy (Routh). As has been mentioned above, the presence of cysts in the discharge is pathognomonic of myxoma chorii.

(7) *The Condition of the Cervix.*—The condition of the cervix is of use, not only in determining whether the patient is pregnant or not, but also in distinguishing between the different forms of abortion. In a threatened abortion the cervical canal usually becomes slightly patulous. If the ovum has been detached and is in process of expulsion, it is forced against the inner os, which accordingly dilates, the external os still remaining closed. The cervix as a result becomes conical in shape, the base of the cone corresponding with the inner os, the apex with the external os (*v.* Fig. 1); in other words, the circumference of the cervix at the cervico-vaginal junction is increased. If the external os will not dilate to allow the ovum to pass through, the latter is gradually expelled into the cervical canal, which dilates to a sufficiently large size to receive it. The inner os may then partially contract again, and the ovum become incarcerated in the

ballooned-out cervical canal. Thus the condition known as cervical abortion arises. If, however, the external os dilates in the usual manner and the ovum is expelled, the inner os closes again completely, while the external os remains dilated for some days. The cervix thus acquires a trumpet-shape, the mouth of the trumpet corresponding to the external os (Fig. 1). If the ovum has been completely expelled, the cervix gradually regains its normal shape; if, on the contrary, a part of the ovum is retained, complete closure of the canal rarely occurs.

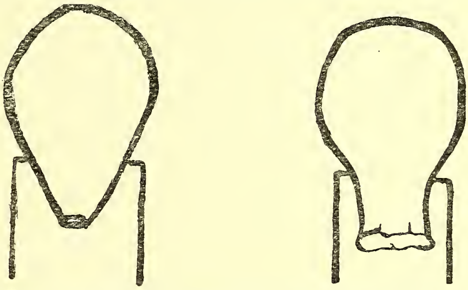

FIG. 1.—Diagram representing the shape of the cervix during, and subsequent to, the expulsion of the ovum.

(8) *The Symptoms of the Patient.*—The three chief symptoms of the patient in either abortion or extra-uterine pregnancy are hæmorrhage, pain, and collapse. In abortion, the three have usually a due relationship to one another. The degree of collapse is in proportion to the amount of hæmorrhage and pain which is occurring. The amount of pain is, however, by no means constant. In the case of a ruptured extra-uterine pregnancy, on the other hand, the first point which may strike us with regard to the case, is that the collapse is altogether out of proportion to the amount of hæmorrhage which is apparently occurring. The accompanying pain is also greater than in abortion. Such a condition should always very forcibly suggest the possibility of internal hæmorrhage. In missed abortion, the previously existing subjective symptoms of pregnancy disappear, and are replaced by various ill-defined phenomena, the result of the absorption of ptomaines from the dead ovum.

These are the principal diagnostic phenomena to be looked for in any case of hæmorrhage during the first three months of pregnancy. It may be of use to sum them up in their relationship to the various causes of hæmorrhage.

A uterus corresponding in size to the period of pregnancy; a varying amount of hæmorrhage and pain, with a corresponding degree of collapse; widening of the cervix at the cervico-vaginal junction; and a slightly patulous condition of the external os, are suggestive of threatened abortion.

Marked ballooning of the cervical canal; closure of the os externum which has a thin parchment-like edge; and a varying amount of dark, perhaps putrid discharge, are indicative of cervical abortion.

The expulsion of a portion of the ovum; slight diminution in size of the uterus; a patulous cervical canal; and a profuse dark discharge, or even a sharp hæmorrhage, are indicative of incomplete abortion.

The expulsion of the entire ovum; a trumpet-shaped condition of the cervix; a marked diminution in size of the uterus; and the gradual diminution and final disappearance of all discharge, are indicative of complete abortion.

A cessation of development, or a gradual diminution in size of the uterus; a dark hæmorrhagic discharge, which may be fœtid; disappearance of the subjective and objective symptoms of pregnancy, and general ill-health on the part of the patient, are suggestive of missed abortion.

The existence of an ovoid pulsating tumour at one side of the uterus; a history of pregnancy; an enlarged uterus, corresponding in size to, or slightly smaller than, the date of pregnancy accounts for; slight irregular hæmorrhages; and perhaps the expulsion of a decidua in which no trace of chorionic villi or amnion can be found, are suggestive of an unruptured extra-uterine pregnancy.

A varying degree of hæmorrhage; the expulsion of a decidua in which no trace of chorion or amnion can be found; considerable pain; collapse out of proportion to the amount of external hæmorrhage; and perhaps the disappearance of a previously-discovered pelvic tumour, with the formation of a new tumour in Douglas' pouch, are suggestive of a ruptured extra-uterine pregnancy.

Marked increase in size of the uterus, out of proportion to the period of pregnancy; a profuse watery blood-stained discharge, perhaps containing cysts; and crampy pains, are indicative of myxoma chorii.

B. HÆMORRHAGES OCCURRING DURING THE SECOND THREE MONTHS

Two varieties of hæmorrhage are met with during the second three months of pregnancy:—

I. Hæmorrhage due to detachment of the placenta.
II. Hæmorrhage due to extra-uterine pregnancy.

I. Hæmorrhage due to Detachment of the Placenta

Hæmorrhages due to detachment of the placenta, occurring during the second three months of pregnancy, occupy an intermediate position between abortion and accidental and unavoidable hæmorrhages.

With the exception of a small proportion of cases which are due to degeneration of the ovum, we find that, while pathologically they can be classified in the same manner as can the hæmorrhages of the last four months, clinically they must be treated as those of the first three. The reason of this is obvious. In the four last months of pregnancy it is always possible to distinguish clinically between the two great classes of placental insertion; in the second three months of pregnancy it is not possible to do so, although pathologically the two classes occur. Consequently, while in the four last months we can diagnose exactly the nature of the case, and treat it accordingly in the most suitable manner, in the second three months all we can do is to recognise that the patient is bleeding, and that the hæmorrhage is either so trifling as only to require palliative treatment, or so serious as to demand more radical measures.

Ætiology.—As has been pointed out above, the hæmorrhage may come from a placenta which is normal in position, or from one which is prævia. The distinction between the two, which cannot be made prior to the expulsion of the ovum, can be made in most cases subsequently. This is done by noting the relationship of the opening in the membranes, through which the fœtus was expelled, to the placenta, if there is such an opening. If the opening is quite close to the placenta, or even through it, it shows that the placenta must have been implanted quite close to, or right over, the os. In some of these cases, however, when the ovum is expelled spontaneously, it is unruptured; while in those cases in which it has to be removed, the membranes become so torn that it is impossible to determine the above relationship. Even in the cases in which the placenta is certainly prævia, it is doubtful whether the situation is the cause of its detachment, or whether rather, the latter is not really due to such similar causes as act in the case of a normally seated placenta,—the fact that the placenta is prævia being a chance accompaniment. It is not very easy to explain why a placenta prævia should be detached any more readily than a normally situated placenta before the lower uterine segment has commenced to form, *i.e.* before the ninth month. The causes of the detachment of a normally situated placenta are to be found in some diseased condition of itself or of the decidua serotina. Accordingly, the following may be stated to be the causes of placental detachment:—

(*a*) Endometritis, by causing an unhealthy condition of the decidua.

(*b*) White infarction of the placenta due to Bright's disease.

(*c*) Syphilis, by affecting either the placenta or decidua. And perhaps

(*d*) Insertion of the whole or part of the placenta in the lower uterine segment.

Symptoms.—The essential symptom of the case is the occurrence of hæmorrhage, perhaps accompanied by the death of the fœtus. In the latter case, decomposition may result, if the membranes are ruptured; or, on the other hand, if they remain intact, the fœtus may merely macerate or mummify aseptically. In the large majority of cases, the hæmorrhage is external, *i.e.* it escapes from the uterine cavity as rapidly as it finds its way into the latter from the blood-vessels. In a smaller proportion of cases, on the other hand, it may remain stored in the uterus, which gradually increases in size to suit the demands of the accumulating blood. If the area of placental detachment is so great as to leave an insufficient amount of surface in contact with the uterus to provide the necessary nutrition and oxygen for the fœtus, the latter dies. In most cases, this event will determine the onset of labour, but in some cases a condition analogous to missed abortion results, and the ovum is retained *in utero.* On the other hand, if there is still a sufficient area of placenta intact to keep the fœtus alive, the latter continues to grow. The condition of the uterus will depend on the foregoing. If the fœtus lives and the hæmorrhage is external, the uterus will continue to increase in size in proportion to the advance of pregnancy. If the fœtus dies, the hæmorrhage being still external, the uterus will diminish in size as the liquor amnii is absorbed, and there will be in addition the symptoms due to the retention of a dead fœtus. The breasts become flaccid, and any secretion which may have appeared in them disappears. At the same time, the subjective symptoms of pregnancy lessen, and the patient suffers to a varying degree from the absorption of ptomaines from the dead fœtus. If the hæmorrhage is internal and the fœtus dead, the patient suffers in the same manner from the retention of the fœtus, but the uterus increases in size. In such cases there will be great difficulty in feeling the fœtal parts; and the uterus, which ordinarily in hæmorrhage is softer than usual, will, if the bleeding is excessive, become extremely tense and hard. Finally, if the membranes have ruptured and saprophytic germs have found their way into the cavity, the fœtus will decompose and a fœtid discharge result.

Accordingly, we may sum up the symptoms as follows:—A varying amount of hæmorrhage either external or internal. A gradual increase in the size of the uterus, if the fœtus lives and the hæmorrhage is external. A diminution in size, if the fœtus dies and the bleeding is external. A more or less marked and sudden increase, if the hæmorrhage is internal. A putrid discharge, if the fœtus decomposes.

Diagnosis.—The diagnosis of external hæmorrhage is obvious. The diagnosis of internal hæmorrhage is made by noting the increase in size of the uterus—an increase which enlarges the uterus out of proportion to the period of pregnancy, by the difficulty in feeling the fœtal parts, and by the general condition of the patient. Internal hæmorrhage at this stage of pregnancy is most likely to be confused with myxoma chorii, but here a mistake in diagnosis is not of any great importance, as in either case the uterus must be emptied. The nature of the discharge will in most cases enable a distinction to be made, as in hæmorrhage it is grumous and contains clots; in myxoma chorii it is thin and watery, while, if myxomatous cysts are found, the nature of the case is at once apparent.

Treatment.—Our treatment of these cases is palliative or active, according to their nature. If the hæmorrhage is slight, and there is no evidence that the fœtus is dead, every effort must be made to check the bleeding by any means short of emptying the uterus. The main factor in attaining this end is absolute rest in bed for at least ten days or a fortnight after the hæmorrhage has ceased. There are certain drugs, which, according to some authorities, can produce a tonic effect upon the uterus or its blood-vessels sufficient to check slight hæmorrhage. Of these, the chief are ergot and strychnine administered in conjunction. Atthill recommends the continued administration of a mixture containing 15 minims of Ext. Ergot. Liq. and 5 minims of Liq. Strychninæ. Hydrastis Canadensis has also its advocates. The objections which are so constantly urged against ergot, do not hold good in the case of the last-mentioned drug. Ergot produces its effect by causing a tonic contraction of the uterine muscle fibres, and in all probability only produces such effect when the contractions have already started of their own accord. Accordingly, in the case of a patient who is bleeding, but who is not in labour, ergot will probably produce little or no effect; while, if any contractions of the uterus have occurred, they will be increased by the ergot given, and so any possibility of their passing off and allowing the pregnancy to continue will be removed. Hydrastis Canadensis, on the other hand, is said to produce its effect by direct action on the muscle fibres of the blood-vessels, and so does not tend to accelerate the occurrence of uterine contractions. The usual dose of it is from fifteen to twenty minims.

Active treatment, consisting in the emptying of the uterus, is indicated under the following conditions:—

(1) If it is obvious that the patient has lost as much blood as is safe.
(2) If the discharge is fœtid.
(3) If the fœtus is dead.

If the indication for delivery is hæmorrhage alone, and there is no sign of intra-uterine decomposition, the easiest method of emptying the uterus consists in passing as many sea-tangle tents into the cervix as the latter will hold, after carefully disinfecting the external genitals and vagina, and then in plugging the vagina tightly with iodoform gauze. It is better to use a number of small tents in preference to a couple of large ones, as the dilating effect of the former is superior. The plug and tents are to be removed in twenty-four hours, or sooner if labour pains ensue. If there is no appearance of the latter when the tents are removed, it will be well to rupture the membranes, to draw down a foot into the vagina, and either to leave the further expulsion to the uterine contractions, or to complete the delivery of the fœtus. In all cases, if contractions do not follow the rupture of the membranes within four to six hours, it will be best to empty the uterus, as there is always a danger of decomposition occurring if we wait too long. An alternative treatment to the use of sea-tangle tents is the plugging of the utero-vaginal canal with iodoform gauze after the method of Dührssen. To do this, the cervix is drawn down by means of an American forceps on both lips, after thorough disinfection of the vagina, and is dilated with Hegar's dilators as far as possible without laceration. The end of a long strip of iodoform gauze, two inches wide, and either single or double as is preferred, is passed by means of a sound as far into the uterus as possible. This is followed by the remainder of the strip, and when it is finished, by another similar strip which is knotted on to the first. Each bit of gauze is passed as high into the uterus as possible, and so the maximum amount introduced. As soon as the cavity is filled, the vagina is plugged tightly. This plug is left *in situ* for twenty-four hours, or until strong labour pains ensue, and is then removed. The advantage of this method is that all hæmorrhage is checked, that intra-uterine decomposition is prevented, and that, even if labour does not follow its removal, there is then sufficient dilatation of the cervix to permit of the easy extraction of the fœtus.

In those cases in which hæmorrhage is complicated by the occurrence of decomposition, the emptying of the uterus must be carried out at one sitting. This is always a more or less troublesome operation owing to the small size of the cervix, and frequently it will only be possible to extract the child after some proceeding akin to embryotomy. The author has found the following plan to be rapid and comparatively easy. Disinfect the vagina thoroughly, and dilate the cervix as far as possible with Hegar's dilators. Pass one finger into the uterus, seize one, or if possible both feet, and draw them down as far as possible, which will usually be until the breech comes into the cervical canal. As soon as they cannot be drawn down any further, introduce a Schultze's spoon-forceps, or other forceps of a similar shape, into the uterus alongside the breech, and catch the latter in it and pull it down. This will result in the tearing off of part of it, and then a fresh hold is taken, and so on until the body of the child is extracted piecemeal. The head will be found the most difficult to remove, as it has the largest diameter, but by means of the forceps it can be crushed and so extracted. A Schultze's spoon-forceps is a very safe instrument for such a course of procedure, as, owing to its shape, it has no tendency to catch the uterine walls, while it easily seizes anything which is lying in the cavity. As soon as the fœtus has been entirely removed, the finger is again passed into the uterus and the placenta detached, while counter-pressure is made upon the fundus by the hand placed on the abdominal wall. The uterus is then well douched with a solution of creolin and water (1 in 320), or other antiseptic, and the cavity plugged with iodoform gauze. The latter must be removed in from twelve to twenty-four hours, and the uterus again douched if there is any rise of temperature.

Prognosis.—The prognosis in these cases is good unless the patient has been allowed to become very much weakened by constant hæmorrhage, or unless she has absorbed an excessive dose of ptomaines from the decomposed fœtus. For this reason the uterus must always be emptied as soon as any of the indications for active treatment, as given above, show themselves.

II. Hæmorrhage due to Extra-Uterine Pregnancy

When the ovum escapes into the broad ligament, and survives that event, the condition is known as a mesometric pregnancy. The peritoneum which forms the broad ligament now occupies the relationship to the ovum which the tube formerly did, and as a result it is liable to share the same fate, *i.e.* secondary rupture of the gestation sac may occur. The immediate result of this rupture depends upon the position of the placenta. If the placenta is situated above the fœtus, it will almost certainly be involved by the rupture; and if this occurs during the latter half of pregnancy, the hæmorrhage will be so profuse as to cause the death of the patient (Bland Sutton). If the placenta lies beneath the fœtus, the latter can escape into the abdominal cavity, when rupture occurs, without necessarily causing very profuse hæmorrhage. The symptoms and treatment of this condition, which are practically the same as those of primary rupture, will be found in the article "Ectopic Gestation" (vol. iii. p. 181). When rupture occurs it may be accompanied by slight uterine hæmorrhage, and perhaps by the expulsion of a decidua.

C. HÆMORRHAGES OCCURRING DURING THE LAST FOUR MONTHS

Hæmorrhages occurring during the last four months may be due to:—

I. Detachment of the placenta.
II. Rupture of the uterus.

I. Hæmorrhage due to Detachment of the Placenta

Cases of hæmorrhage from detachment of the placenta are divided into two great classes:—

A. Accidental hæmorrhage, due to the detachment of a normally situated placenta.

B. Unavoidable hæmorrhage, due to the detachment of a placenta prævia.

A. Accidental Hæmorrhage

Accidental hæmorrhage is the term applied to hæmorrhage due to the detachment of a normally seated placenta, *i.e.* a placenta no part of which comes into the lower uterine segment.

Frequency.—The frequency of accidental hæmorrhage is very difficult to ascertain, on account of the cursory manner the subject is treated in the majority of text-books. At the Rotunda Hospital, amongst 15,109 cases of labour there were 113 cases of accidental hæmorrhage, *i.e.* one in every 133·7 cases. Almost all these cases were cases of external accidental hæmorrhage.

Ætiology.—The most frequent cause of detachment of the placenta is to be found in some factor which weakens the adhesions between the latter and the uterine wall. Of these, the commonest are endometritis, Bright's disease, and syphilis. Of the three, Bright's disease is the most important, and is practically the sole cause of the more serious forms of accidental hæmorrhage. It favours the rupture of vessels in the placental substance, and blood escaping from them forces its way between the placenta and the uterine wall, thus causing the detachment of the former. Another cause of quite a different nature from the foregoing is to be found in undue shortness of the cord, either actual or the result of the twisting of the latter round the fœtal parts. When such a condition is present, so great traction may result upon the placenta while the fœtus is being expelled as to cause detachment.

Varieties.—Two chief forms of accidental hæmorrhage are met with, according as the blood escapes externally, or is stored up in the uterus. These are:—

(A) Concealed accidental hæmorrhage.
(B) External accidental hæmorrhage.

These two varieties differ so markedly from one another, as far as the conditions present and the appropriate treatment are concerned, that they must be described separately.

(A) *CONCEALED ACCIDENTAL HÆMORRHAGE.*—Concealed accidental hæmorrhage is the term applied to accidental hæmorrhage when the blood is stored up in the uterus instead of escaping into the vagina. In such a condition the blood may be found in one of four situations:—

(1) Behind the placenta, the whole of which is separated except its edges.
(2) Behind the membranes, which are detached except round the internal os.
(3) In the amniotic cavity.
(4) Behind the presenting part, if the latter fills the lower uterine segment completely.

Concealed accidental hæmorrhage is, with the exception of acute sepsis, the most serious accident which can happen to a pregnant woman. This is due not only to the difficulty of diagnosing its occurrence at an early stage, but also to the fact that we have an entirely different condition of the uterus from that which we find in external hæmorrhage. In concealed hæmorrhage the blood collects in the uterus, because the latter dilates so easily that the intra-uterine pressure is never sufficiently great to overcome the slight resistance offered to its outflow through the cervix. In external hæmorrhage quite the opposite is the case. Here, the intra-uterine pressure is so rapidly raised, by the escape of blood from behind the placenta, that such blood is almost immediately forced through the cervix. The cause of the difference in the two cases is, that in internal hæmorrhage we have to deal with a uterus the muscle fibre of which has for some reason lost its normal contractile tone, and whose elasticity is, as a result, impaired; while in external hæmorrhage, the uterine fibre possesses that normal tone, and hence may be described as "healthy." It is quite obvious that a ruptured vessel can only bleed into a closed cavity as long as the pressure inside that cavity is less than the blood pressure. Once they equalise one another the bleeding ceases. If the blood can escape from the cervix as quickly as it flows from behind the placenta, then such equalisation never takes place. If the uterus is healthy in tone and the outflow of blood from the cervix is prevented, the two pressures rapidly equalise one another and the bleeding ceases. If, however, the uterine fibre has lost its tone to such an extent that it will permit the uterus to dilate before the blood pressure, then not only does the intra-uterine pressure never rise sufficiently to check the hæmorrhage, but it is not even sufficient to force the blood which has escaped through the cervix. In this manner concealed hæmorrhage commences. The amount of hæmorrhage which the uterus will permit to accumulate inside will depend upon the extent to which the muscle fibre is affected. The first sign that the latter is commencing to react against the distension it is undergoing, is the escape of blood externally, and accordingly the earlier that occurs the healthier may the condition of the uterus be judged to be. These are all important facts to grasp, as they explain the essential differences between external and internal hæmorrhages so far as accompanying conditions go. They also indicate a means by which external hæmorrhage may be checked, and the necessity for uterine co-operation in carrying out such a treatment.

Symptoms.—The symptoms of concealed hæmorrhage fall under two heads:—

(1) Those due to the loss of blood, and common to all forms of hæmorrhage.
(2) Those due to the accumulation of blood in the uterus.

(1) The first group does not require any special attention here. The symptoms are given in full in the section dealing with post-hæmorrhagic collapse (*v.* "Labour, Post-partum Hæmorrhage," vol. vi. p. 281).

(2) The most prominent symptom in the second group consists in the

gradual enlargement of the uterus, which may dilate to such an extent as to fill the entire abdomen and cause pressure on the diaphragm. The uterus at first becomes tense, and then of an almost woody hardness, and is markedly tender to the touch. All possibility of palpating the fœtus disappears. At the same time there is severe abdominal pain, akin to the pain caused by the tonic contraction of the uterus in cases of threatened rupture.

Diagnosis.—The diagnosis of concealed hæmorrhage due to detachment of the placenta can be made by means of the symptoms given above.

Tenderness of, and increase of size in, the uterus, with ever-increasing pain, are almost pathognomonic of intra-uterine hæmorrhage—an important fact to bear in mind even when there is a sufficient amount of external hæmorrhage to account for any other symptoms.

Treatment.—The treatment of concealed hæmorrhage is so far by no means satisfactory. Mild cases which occur during labour are not very difficult to treat, but severe cases starting prior to the onset of labour are most serious. From what has gone before, it will be obvious that plugging of the vagina—a line of treatment which is so satisfactory in external hæmorrhage—is here of no avail. In those cases in which we are able to recognise the very commencement of the hæmorrhage, and while still the patient shows no marked symptoms of bleeding, some good may be gained by the application of a tight abdominal binder, and possibly by the administration of ergot; while the application of a firm vaginal compress —as presently described—may bring on labour before the hæmorrhage has reached a formidable amount. Once the patient begins to have strong uterine contractions a great deal of the risk of the case disappears. Immediate rupture of the membranes is then indicated, with the object of permitting the blood to escape and the uterus to contract down upon the fœtus. The remaining treatment of the case is the same as that of external accidental hæmorrhage when the patient is in labour. Unfortunately, many cases of concealed hæmorrhage have a sudden onset before the patient is in labour, and do not admit of any temporising measures. In such cases the bleeding must be immediately checked, and in order to do this the seat of the hæmorrhage must be directly reached. Two lines of treatment present themselves—*accouchement forcé*, and supra-vaginal amputation of the uterus either by Porro's method or not, as may be preferred. These are both most serious measures, and convey *per se* a great element of danger into the case. The only excuse for their adoption is that the danger which they are directed against is so urgent that even the risk of Porro's operation, or *accouchement forcé*, with a collapsed patient, is to be preferred.

By *accouchement forcé* is meant the dilatation of the cervix followed by version and the extraction of the fœtus. It is performed as follows:—Place the patient in the cross-bed position, with her hips well over the edge of the bed; if possible an anæsthetic should be given. The first step is the dilatation of the cervix. This can be best accomplished, in cases in which the inner os is dilated, by means of several incisions through the walls of the cervical canal, radiating outwards from the os externum. This, however, can only be practised in primiparæ, in whom the os internum is found dilated previous to the onset of labour. In multiparæ, where the cervix is still long and the inner os closed, mechanical dilatation must be practised. This is usually performed by means of the fingers. First one finger is introduced gently through the cervix, and then, equally gently, another beside the first. Then a third finger, and so on, until finally the whole hand can be introduced. If there is not sufficient dilatation at the start to allow of the introduction of one finger, a few Hegar's dilators must be used, and by this means the cervical canal enlarged. As soon as the whole hand has been passed into the uterus, the foot of the fœtus is seized and drawn down. By gradually pulling upon it the size of the cervical canal is still further increased, and finally the breech can be brought through. The remainder of the fœtus is then extracted in the usual manner. If the placenta is not immediately expelled by the uterine contractions, it should be removed by the hand, and in all cases the utero-vaginal canal must be plugged firmly with iodoform gauze.

Supra-vaginal amputation of the uterus is perhaps to be preferred to the foregoing. It is easier if there is sufficient assistance. It is quicker if Porro's operation is performed. There is less blood lost during its performance, and there is no more, if as much, shock. The objection to it is the greater number of assistants which it requires. As to the method of performing it there is nothing very special to be said. For the description of the operation the reader is referred to the article on "Hysterectomy," vol. viii. p. 537. Porro's operation is the most rapid method, but convalescence is slower than if an intra- or retro-peritoneal treatment of the stump is adopted.

Prognosis.—The prognosis for the mother is very serious, especially in those cases which come on before labour starts; for the child it is almost absolutely bad.

(B) *External Accidental Hæmorrhage.*—External accidental hæmorrhage is the term applied to accidental hæmorrhage when the blood escapes from the uterus according as it is poured out from behind the detached placenta. It is a serious accident, but by no means as serious as is concealed hæmorrhage. In the majority of cases the blood pours into the vagina as rapidly as it escapes from the ruptured vessels. Sometimes, however, a certain amount of blood may first accumulate in the uterus, and then commence to escape externally as soon as the latter reacts against the blood pressure, *i.e.* as soon as the intra-uterine pressure becomes sufficiently great to overcome the resistance to the escape of blood.

Symptoms.—The escape of blood from the vagina is the most marked symptom, accompanied by the usual symptoms of collapse if the bleeding continues long enough. In those cases in which there is concealed hæmorrhage as well, the symptoms which have been given under the head of concealed hæmorrhage are met with.

Diagnosis.—The diagnosis of the case has to be made from hæmorrhage due to placenta prævia, *i.e.* unavoidable hæmorrhage. To do this, examine the patient vaginally, with the object of determining whether the placenta can be felt in the lower uterine segment or not. If it can be felt, it is a case of placenta prævia; if it cannot, of accidental hæmorrhage. In some cases in which the placenta cannot be felt, it may possibly be a case of lateral placenta prævia, but still it is to be treated as if it was one of accidental hæmorrhage. The reason for this is that, if the placenta lies at a height at which it cannot be felt from the vagina, though actually it may be a placenta prævia, still the treatment suitable for accidental hæmorrhage will be found to be the more efficacious.

Accidental hæmorrhage may be diagnosed by abdominal palpation by excluding the possibility of placenta prævia. If the head is found to be fixed in the pelvis, and the patient is bleeding, it is certainly not a case of placenta prævia.

Treatment.—The treatment of the case, as well as the prognosis, depends to a very great extent upon the time at which the hæmorrhage starts, *i.e.* whether during pregnancy or labour—when there are no uterine contractions, or when there are. If the patient is in labour the danger of the case is greatly diminished, and the treatment is comparatively simple. If she is not in labour, the reverse is the case.

If the patient is not in labour when the hæmorrhage starts, there are two points towards which our treatment must be directed. The first is the immediate checking of the hæmorrhage; the second, the induction of labour. If the hæmorrhage can be satisfactorily stopped for the time necessary to bring on uterine contractions, the case is practically reduced to one of hæmorrhage during labour, and the prognosis consequently improved. As has been shown above, there is very little room for blood to accumulate in a healthy uterus filled by an unruptured ovum. Either it must escape from the cavity as rapidly as it pours out from behind the placenta, or the intra-uterine pressure will become equal to the blood pressure, and the bleeding cease. Again, the fact that the hæmorrhage is external tends to show that the uterus is "healthy," as is demonstrated by the statistics of cases treated on this basis. In no case of accidental hæmorrhage at the Rotunda Hospital, has plugging converted an external into an internal hæmorrhage, an accident which would surely occur if the uterine fibre had lost its tone. If we prevent the blood which is being poured out from behind the placenta from leaving the uterus, the pressure inside the latter will rapidly become equal to the blood pressure, and the hæmorrhage will cease. The easiest and most effectual method of doing this is by plugging the vagina tightly, and so compressing the cervix. This will check the hæmorrhage, and at the same time it will carry out our other object, which is a necessary part of any successful treatment, namely, it will induce labour. Furthermore, labour thus brought on comes on gradually, and does not cause any aggravation of the shock from which the patient is already suffering, as do the more rapid methods of emptying the uterus. On the contrary, ample time is allowed for the patient to rally from the collapse, which the hæmorrhage has caused, before the uterus empties itself.

The operation of plugging is carried out as follows:—Place the patient in the cross-bed position, with her hips well over the edge of the bed. Administer an anæsthetic if necessary, and this is most frequently the case, as the firm application of a plug which is required in these cases is rather a painful procedure. Wash the external genitals and douche out the vagina thoroughly. Then pass a posterior speculum, and, with strips of iodoform gauze soaked in lysol solution (0·5 per cent), plug tightly round and over the cervix. A speculum is not absolutely necessary, but if the patient is not under an anæsthetic, it renders the proceeding less painful by protecting the perineum. The remainder of the vagina is then plugged as tightly as possible with balls of cotton-wool about the size of a golf ball, which have been previously sterilised by boiling and then soaked in lysol solution. This plugging is continued until no more can be pressed into the vagina (*v.* Fig. 2). The patient is then put back to bed, and an abdominal binder pinned as tightly as possible round the uterus, while a T-binder is brought down between the thighs, and also

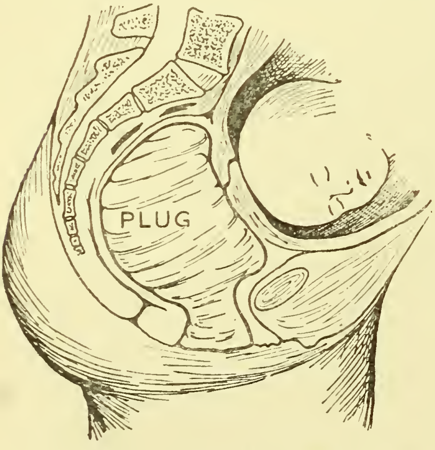

FIG. 2.—Diagram showing a vaginal tampon *in situ*.

fixed firmly. By this means the uterus is compressed between the plug in the vagina and the abdominal binder, and the intra-uterine pressure is raised. The plug is left in until strong labour pains ensue, which usually happens in from two to four hours. In some cases the onset of labour is slower than this, and in such the plug must be removed in twenty-four hours for fear of decomposition taking place. If hæmorrhage comes on again it can be replaced, but this is rarely necessary. While the plug is *in situ* the patient must be carefully watched to see that concealed hæmorrhage is not occurring. The first sign of such a condition is afforded by the patient complaining that the abdominal binder is becoming tighter than she can bear—a condition which is caused by the increase in size of the uterus.

The success of this treatment depends upon three points:—

(1) The uterus must be "healthy."
(2) The ovum must be intact.
(3) The plug must be tightly applied.

If the patient is in labour when the hæmorrhage starts, the first thing to be done is to rupture the membranes. This treatment, which is frequently recommended as *the* treatment in all cases, is now most suitable. Every time the uterus contracts it drives the presenting part or the liquor amnii against the membranes lying over the os internum, and these latter in turn communicate this downward impulse to the placenta. In this manner, with each contraction, while the membranes are unruptured, a fresh piece of placenta is detached. When the membranes are ruptured the presenting part can advance without causing any such drag upon the placenta, and at the same time, owing to the escape of liquor amnii, the uterine cavity is diminished in size, thus causing a corresponding diminution in the placental site. Rupture of the membranes can be accomplished by means of a stilette or the finger-nail. Care must be taken to ensure the gradual escape of the liquor amnii, especially in those cases in which the presenting part is not fixed, lest the cord should be carried down at the same time. In addition to rupturing the membranes, a hot vaginal douche may be given to stimulate uterine contractions, and massage of the fundus, with the same object, may also be tried.

If such treatment fails to check the bleeding, our further plan of action depends upon the size of the os. If the latter is still quite small, the vagina must be plugged as before. This treatment, which would be most unsafe after the membranes are ruptured, if there were no labour pains, becomes again safe if there are strong contractions, as the latter ensure the obliteration of any space round the fœtus, left by the escape of the liquor amnii. The plug is left *in situ* until pains of an expulsive character set in. It may then be removed. The use of the plug in cases such as this is, however, very seldom required, as in the large majority of cases hæmorrhage ceases when the membranes are ruptured in the presence of uterine contractions, or else it is possible to empty the uterus. If the os is half or more dilated, and the presenting part is not fixed, podalic version, followed by extraction, is the line of treatment indicated. If, however, the patient is very much collapsed, and all hæmorrhage ceases as soon as a foot has been brought down into the cervical canal, it may be advisable to leave the expulsion of the child to the natural efforts. Version in these cases can usually be carried out by the internal method; in some cases it may be necessary to adopt the bi-polar method, as will be presently described. If, on the other hand, the os is fully or almost fully dilated and the head is fixed, immediate delivery by the forceps is indicated.

Other Modes of Treatment.—The above is the treatment which the writer recommends, his reason for which will be found below. But, in addition, there are other methods which are recommended by various authorities. Of these the following are the chief:—

Rupture of the membranes in every case.—Rupture of the membranes in every case is the treatment which has perhaps the greatest number of supporters. It is a treatment which is easily carried out, and in some cases is sufficient. If we can be certain that the uterus will contract down upon the fœtus, immediately after the escape of the liquor amnii, there are no very great objections to trying such a course of action, as if it fails it is still possible to resort to plugging. But, if the uterus does not contract down upon the fœtus, there is a large space left inside it for blood to collect in, consequently plugging is impossible; and, if hæmorrhage continues, there is nothing left but *accouchement forcé*—the most dangerous of all treatments. Accordingly, rupture of the membranes should be left for those cases in which we can be certain that, after it is done, the uterus will contract down; that is, it should only be performed when the patient is in labour.

Accouchement forcé.—*Accouchement forcé*, as has been stated before, is the most dangerous of all treatments. It is quite unjustifiable in any case of external hæmorrhage so long as the membranes are intact. The great objection to it lies in the fact that intra-uterine manipulations, particularly the violent manipulations of *accouchement forcé*, tend directly to aggravate the collapse into which the patient falls in cases of severe hæmorrhage. Delivery, even when effected by the natural efforts, increases the collapse, and consequently any treatment which will check the hæmorrhage, and also afford an interval during which the patient can revive before the uterus is emptied, is the treatment that is to be preferred.

Prognosis.—The prognosis in external accidental hæmorrhage depends very much on the form of treatment adopted. In the Rotunda Hospital, fifty-six cases of accidental hæmorrhage of all degrees of severity were treated between November 1889 and November 1893. *Accouchement forcé* was the mode of treatment adopted in all the serious cases, and of those so treated six died. From November 1893 to November 1900, fifty-seven cases were treated. *Accouchement forcé* never was performed, its place being entirely taken by plugging. Out of this number one patient died, and she had been admitted to the hospital thirty minutes previously with the membranes ruptured. The number of serious cases during these two periods was relatively the same. The treatment by rupture of the membranes in all cases is credited with a mortality of ten to twelve per cent by its supporters; and yet a well-known obstetrician used to consider, that the fact of a student recommending plugging of the vagina as a treatment for accidental hæmorrhage was sufficient ground for depriving him of his examination. The subject is so important that the writer wishes to state again that the advantages of the vaginal plug lie in the following facts:—That it at the same time checks the hæmorrhage and brings on labour; that labour so induced comes on gradually, and at a time when the patient has had an interval of rest during which she can recover from her collapsed condition; that the vaginal plug applied in suitable cases does not tend "to convert an external into an internal hæmorrhage"; and that, even if the bleeding continues after the plug has been applied, the patient is in no worse position for the adoption of any other treatment.

The fœtal mortality is very high—from 40 to 60 per cent. It will be discussed subsequently.

B. Unavoidable Hæmorrhage

Unavoidable hæmorrhage, or hæmorrhage due to placenta prævia, is the term applied to the bleeding caused by the detachment of a placenta, any portion of which is implanted so near the os internum, that it becomes separated during the formation of the lower uterine segment.

Frequency.—The statistics relating to the frequency of placenta prævia are very conflicting. Kaltenbach gives the proportion of 1 in 1500 to 1600, Winckel 1 in 1500, Ribemont-Dessaignes 1 in 1000, the Boston Lying-in Hospital 1 in 239. At the Rotunda Hospital among 15,109 cases of labour there were 86 cases of placenta prævia, or 1 in 175·68.

Ætiology.—The ætiology of placenta prævia is very obscure. It is more frequent amongst multiparæ than amongst primiparæ, and is also relatively more frequent in the case of twin pregnancies. Of the many theories which have been brought forward, three are specially worth attention.

(1) That, owing to the effects of a previous endometritis, the cavity of the uterus has become so enlarged that its walls are no longer in contact with one another. Consequently, when an ovum enters the uterus through the Fallopian tube, instead of being detained at the fundus by the pressure of the mucous membrane, it drops downwards and becomes attached to the lower portion of the uterus. Support is given to this theory by the fact that placenta prævia almost always occurs in patients who have suffered from endometritis, as shown by menstrual disturbances, leucorrhœa, and abortions.

(2) Hofmeier and Kaltenbach attribute placenta prævia to a portion of the placenta being developed out of chorionic villi which are implanted in the decidua reflexa, instead of only out of those that are implanted in the decidua serotina. The tongue of placenta thus formed becomes attached to the lower pole of the uterus as the ovum grows.

(3) That a placenta prævia is merely a normally situated placenta, which, owing to its size, has extended into the lower uterine segment. This may be the case in some instances, but in the majority of cases the placenta is no larger than is normal.

Whatever may be the cause of the low insertion of the placenta, the bleeding which results from it is started by the expansion of the lower pole of the uterus consequent upon the formation of the lower uterine segment during the later months of pregnancy. As a result, the placental site becomes too large for the placenta, and detachment ensues (Jacquemier). Pinard thinks, on the other hand, that the detachment is due to the painless contractions of the uterus, which, by diminishing the size of the middle and upper portions of the cavity, tend to increase the size of the lower, and so to pull it away from the placenta.

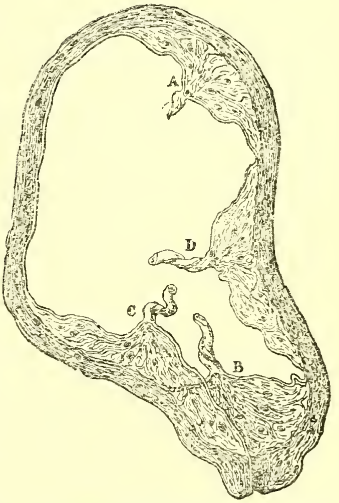

FIG. 3.—Diagram representing the various situations of the placenta. A, Normal situation; B, placenta prævia centralis; C, placenta prævia marginalis; D, placenta prævia lateralis. (Modified from *The Norris Text-book of Obstetrics.*)

Occasionally hæmorrhage may occur, due, not to the detachment of the placenta, but to the rupture of the circular sinus, a large vein which runs round the placenta. This is an accident which is specially likely to occur when the edge of the placenta is over the os, but its occurrence has also been noticed in cases of normally situated placentæ.

Varieties.—A placenta prævia is termed central, marginal, or lateral, according as it completely covers the os, just reaches its edge, or merely extends into the lower uterine segment without reaching the inner os (*v.* Fig. 3). It will be at once obvious that these relationships will materially alter according to the size of the os. Thus, what may be apparently a central placenta prævia at the commencement of labour, will as the os dilates become marginal, and so it is essential for clearness' sake to specify the size of the os at the time at which the examination is made.

Symptoms.—The chief symptom is, the occurrence of an attack of hæmorrhage, coming on without any apparent cause, and of more or less severity. The first attack of hæmorrhage, if not treated, may be sufficiently profuse to cause the death of the patient, but such an occurrence is very rare. More commonly she recovers from it, only to have a second attack in from eight to ten days, and this in turn is followed by others. The hæmorrhage of placenta prævia is, essentially, a hæmorrhage of repetitions (Ribemont-Dessaignes). As in accidental hæmorrhage, the bleeding is most severe during a contraction of the uterus. This, in placenta prævia, is due to the fact that the vessels which supply the placenta lie below the contraction ring, and consequently during a contraction not only are they not obstructed, but the pressure in them is increased, owing to the obstruction offered to branches running above the contraction ring. If the bleeding continues, the usual symptoms of collapse appear.

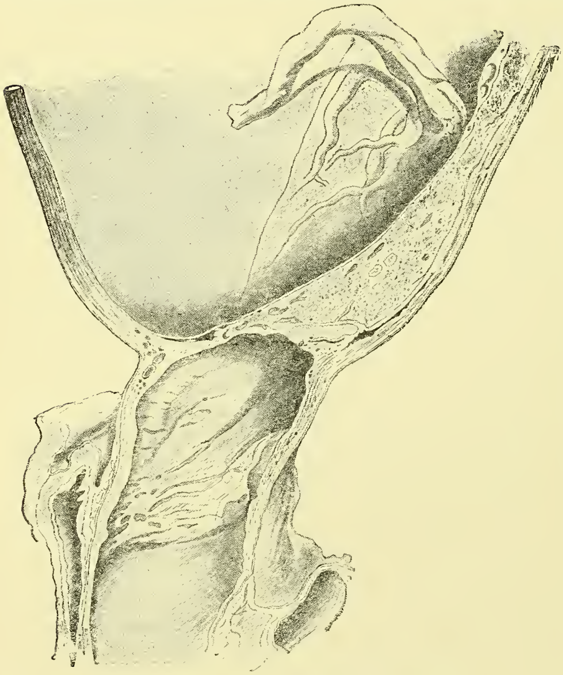

Fig. 4.—Marginal placenta prævia. (Ahlfeld.)

Diagnosis. — There is but one really reliable method of diagnosing a placenta prævia, that is by feeling it through the cervical canal, or, if that is closed, through the lateral fornices. In almost all cases in which our attention is called to the condition by hæmorrhage, the cervix will be found to be sufficiently dilated to admit two fingers, so that there is rarely any difficulty in determining the position of the placenta. The latter is felt as a spongy mass, either completely covering over the os internum or lying to one or other side of it (*v.* Fig. 4). A blood-clot which has become adherent to the membranes in either of these situations is the thing most likely to be confounded with it. A distinction can be made by noting the manner in which a clot can easily be squeezed through between the fingers, while a portion of placenta cannot. If the cervical canal is closed, the placenta can be felt as a thick soft mass lying between the uterine wall and the presenting part at one or other side. The cervix and the lower uterine segment are also softer than usual, and the vessels of the lateral fornix are enlarged and pulsate more strongly than normal. If the placenta cannot be felt, the case is to be treated as one of accidental hæmorrhage.

A placenta prævia may also be sometimes diagnosed by abdominal palpation. This can be done by noticing that there is something which either displaces the presenting part to one or other side of the false pelvis, or prevents it from descending through the brim. Then, on very careful palpation, a soft mass may be felt at the side from which the presenting part has been displaced. If the presenting part has become fixed in the brim, it is almost certain that the case is not one of placenta prævia.

Treatment.—The first point to recognise with regard to the treatment of placenta prævia is that, immediately the condition is recognised, steps must be taken with the view of ending the pregnancy, whether the bleeding has temporarily ceased or not. The only exception which may be made to this rule, is in those cases in which the patient is in such circumstances that, if the bleeding restarts, she can be immediately treated. Many cases have been lost because, on the arrival of the doctor, the bleeding was found to have ceased, and consequently nothing was done, with the result that the bleeding recurred, with fatal consequences.

As in accidental hæmorrhage, the line of treatment adopted depends to a very great extent upon whether the patient is in labour or not. If she is in labour, the treatment of the case is comparatively simple, both because uterine contractions are present, and also because the fact that hæmorrhage did not occur until the patient came into labour, shows that the placenta is not very close to the os.

Again, as in accidental hæmorrhage, the objects of our treatment are to check the bleeding and to bring on labour gradually. These objects are best attained by the method introduced by Braxton Hicks. This consists in turning the child by podalic version into a breech presentation, rupturing the membranes, and drawing down a foot. The remainder of the expulsion of the fœtus is then left to nature. The result of this treatment is that the hæmorrhage is checked, owing to the pressure of the breech and subsequently of the body of the child against the placenta, while the rupture of the membranes and the partial extraction of the fœtus ensure the onset of labour. If there is any return of the bleeding, a little traction on the foot will drag more of the breech downwards, and so increase the pressure upon the placenta. If, as may happen in very rare cases, labour pains do not come on within twelve hours, or if, even before that time—the fœtus being dead—signs of decomposition set in, delivery must be accomplished by means of gentle traction upon the foot. The method of performing bi-polar version, which the author prefers, differs somewhat from the more classical method of Braxton Hicks, and so a short description of it may not be out of place. The operation is carried out as follows:—Place the patient in the cross-bed position, and under an anæsthetic, unless her condition forbids the use of one. Ascertain the exact position of the fœtus by abdominal palpation, and then by external version turn the fœtus so that it lies directly transversely—its head at one side of the uterus, its breech at the opposite, and its back uppermost. By this means the legs of the child are brought to lie in the region of the os internum. This is the first part of the operation. The second part is commenced by washing the external genitals thoroughly and douching out the vagina. Then as much of the hand as is necessary is passed into the vagina, and two fingers introduced into the cervix. If the placenta is central, the fingers must be passed through it, and the foot subsequently brought down through the opening thus made. By firm external pressure on the breech with the other hand, the feet are made to descend still further, and then one of them can be seized between the fingers in the uterus. As the cervical canal is usually very small, the foot must be drawn down in such a manner as to take up the least room, *i.e.* by bringing the toes first and the rest of the foot in an extended position. In some cases it may happen that the os, which is large enough to admit two fingers by themselves, or a foot by itself, will not allow the three to come down together. In such a case the following manœuvre is sometimes successful. With the fingers passed through the cervix, draw the tips of the toes downwards through the inner os as far as possible. Next remove the fingers and keep the foot in the same position by means of external pressure upon the breech. Then, with the fingers in the vagina, encircle the cervix and push it up gently over the toes, while at the same time the external hand presses the breech down. By this means half of the foot is brought outside the os externum, and is caught by the fingers. A little traction then draws it down (*v.* Fig. 5). At the same time that this final traction is being made, the abdominal hand pushes the fœtal head upwards to the fundus of the uterus, and so version is completed. The last step consists in tying a strip of iodoform gauze to the foot, as by this means traction can be most easily applied if necessary.

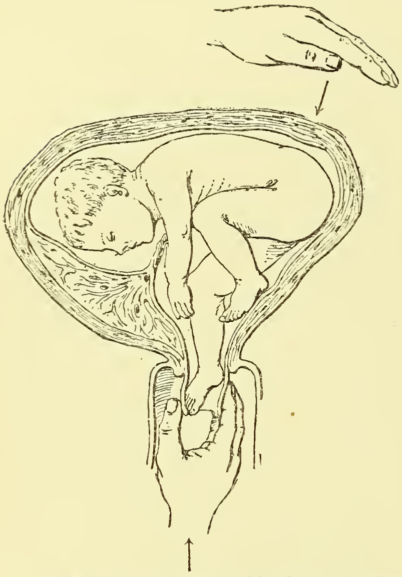

FIG. 5.—Method of completing bi-polar version in a case in which the size of the os will not permit of the presence of the foot and the two fingers at the same time. The hand in the vagina pushes the cervix upwards while the foot is made to descend by pressure upon the breech (diagrammatic).

In order that this line of treatment can be carried out satisfactorily two conditions must be fulfilled:—

(1) The cervical canal must be of sufficient size to admit two fingers at least. If the hæmorrhage is at all severe this condition is practically always fulfilled.

(2) The membranes must be intact, or only quite recently ruptured. If the uterus has become contracted down upon the fœtus it will be found impossible to turn except by internal version, and there is rarely or never sufficient cervical dilatation to allow of this. This condition will also be always fulfilled unless an ignorant attendant has resorted to rupture of the membranes, with the idea that such treatment is sufficient.

In the rare case in which the cervical canal is not sufficiently dilated to admit two fingers, and in which the hæmorrhage is so severe that it is impossible to wait for a short time to allow it to dilate, the firm plugging of the vagina with iodoform gauze and cotton-wool is indicated. This is performed in the same manner as has been already described under the head of accidental hæmorrhage.

When the patient is in labour, the treatment of the case is the same as that of accidental hæmorrhage occurring under the same conditions. Commence by rupturing the membranes, a proceeding which is usually sufficient. This acts by allowing the head to advance without causing traction through the membranes upon the placenta, and at the same time the descending head presses upon the placenta and checks hæmorrhage, as does the breech after version has been performed. If this is not sufficient to check the bleeding, internal version may be performed, followed or not by extraction, according to the condition in which the patient is and the size of the os. If the head is fixed and the os sufficiently dilated, the forceps may be applied.

Other Modes of Treatment.—As in accidental hæmorrhage, the above is the treatment which the author considers most suitable. Other lines of treatment have been recommended by various authorities, and of these the following are the chief:—

(1) Champetier de Ribes' Bag.—The plugging of the lower uterine segment by means of a Champetier de Ribes' bag is perhaps the line of treatment which, after bi-polar version, has the greatest number of advocates at the present day. A Champetier de Ribes' bag is a pear-shaped bag made of waterproofed silk. Its wide end or base is three-and-a-half inches across, while the narrow end tapers to the size of a quarter-inch rubber tube, with which it is continuous, and by which it is filled. The bag, or hydrostatic dilator as it is termed, is used as follows:—The patient is placed in the cross-bed position, with her hips well over the side of the bed, and the vagina is thoroughly disinfected. The membranes are then ruptured immediately over the inner os, and the bag is passed upwards into the amniotic cavity by means of a forceps made for the purpose. It is then distended slowly by injecting into it any antiseptic fluid, either by attaching a syringe, the tube of a uterine douche, or other form of irrigator, to the nozzle. As soon as it is full the tap is turned off to prevent the fluid escaping. Finally, the end of the bag or colpeurynter is connected with the foot of the bed by means of an elastic cord, which is made as tight as the patient can bear. The effect of the introduction of a pear-shaped bag like Champetier de Ribes' into the amniotic cavity is to cause a compression of the placenta against the uterine wall, and at the same time a dilatation of the cervical canal, in very much the same manner as the breech of the child does in Braxton Hicks' method; while the rupture of the membranes also helps to bring on uterine contractions. The bag is allowed to remain in the uterus as long as it will, that is, until the cervical canal is so dilated that it slips out. If this does not happen within twelve hours the bag must be removed, the child turned by bi-polar or internal version, according to the size of the os, and extracted immediately or not, according to the condition of the patient. The average time which the bag takes to dilate the cervix is said to be five hours and ten minutes (Blacker). In the case of a central placenta prævia, the bag must be introduced through an opening in the placenta made over the inner os.

The advantages claimed for this course of procedure over Braxton Hicks' method are the ease with which it can be carried out, and the improved fœtal prognosis. While fully recognising it as a perfectly scientific mode of treatment, and one which gives excellent results, the writer considers it to be inferior, for general use, to version. In careless hands it is more liable to cause sepsis, inasmuch as a possibly non-sterile foreign body is lying for some hours in the uterus; and its performance, which may not be required very frequently, necessitates the use of a special apparatus, and one, moreover, which is very liable to be destroyed by lying by.

(2) *Accouchement forcé.*—The adoption of *accouchement forcé* is even more

dangerous in the case of placenta prævia than it is in the case of accidental hæmorrhage, owing to the condition of the cervix. It is most essential to remember that in these cases no attempt may be made to deliver the fœtus through an incompletely dilated os.

(3) Plugging of the Vagina.—Plugging of the vagina is an objectionable and unnecessary course of procedure in placenta prævia. There is always some risk of sepsis following the use of a plug, and this risk is very much increased in those cases in which the placenta is situated in the lower uterine segment, as the inoculation of the placental site by the extension of vaginal infection is so easy. Further, we have an excellent and safe mode of treating these cases which we do not possess in the case of accidental hæmorrhage, viz. version. Accordingly, the use of the plug should be limited to the small proportion of cases in which it is absolutely necessary, viz., to those cases in which the patient is bleeding, and in which the cervical canal is not sufficiently dilated to admit even two fingers.

(4) Partial Detachment of the Placenta.—Detachment of the placenta from the lower uterine segment was the main feature of the treatment recommended by Barnes. The steps of his procedure, in his own words, are as follows:—

"(*a*) Rupture the membranes; this disposes the uterus to contract.

"(*b*) Apply a firm bandage over the abdomen.

"(*c*) A tampon may be introduced to gain time, but it is not necessary to do so. Watch; observe with vigilance.

"(*d*) Detach all the placenta adhering within the inferior zone, and always watch. If there is no hæmorrhage, wait a little. The uterus may perhaps do what is necessary. If this fails, dilate the cervix with the hydrostatic dilator. Wait and watch. If the natural forces fail, employ the forceps, which gives the best chance to the child, or as a last resort perform version.

"(*e*) Avoid as far as possible everything that predisposes to septicæmia."

Barnes' treatment has now but very few supporters. At the time at which it was introduced it was a considerable advance over the methods in use, inasmuch as it prevented the rapid emptying of the uterus. It is, however, very much inferior to either Braxton Hicks' method or to the use of Champetier de Ribes' bag. It is a very tedious course of procedure for the patient, and one which affords many opportunities of inoculating her with septic organisms. In placenta prævia, more than in any other condition, the number of vaginal examinations must be brought down as near the irreducible minimum as possible, on account of the ease of infecting the placental site. But Barnes' method demands repeated examinations in order to carry out its multiple steps, and to ensure that the necessary "vigilance" is being used.

Complications.—Although the main danger caused by placenta prævia is death from hæmorrhage coming from the placental site, there are still other grave risks sufficiently imminent to require careful consideration during the treatment of a case. Of these the following are the chief:—

(1) Laceration of the Cervix.—As has been already mentioned, laceration of the cervix is very prone to occur in these cases, owing to the softened condition of the cervix resulting from its increased blood supply. Further, for the same reason that they occur, they are the more dangerous, as, if any of the large vessels going to the placenta are torn across, fatal traumatic hæmorrhage will very probably result. It is this which makes *accouchement forcé* so dangerous a proceeding in these cases, and which furnishes a direct contra-indication to the extraction of the child through an incom-

pletely dilated cervix. If post-partum hæmorrhage follows the birth of the child in these cases, the possibility of its being due to a laceration must always be borne in mind.

(2) Septic Infection.—In consequence of the proximity of the placental site to the vagina, the absorption of septic organisms, or of ptomaines, may very easily take place. Such absorption may occur not only during labour, but also during the peurperium. Accordingly, as has been already said, vaginal examinations must be avoided as far as possible during labour, and any appearance of sapræmic change in the vaginal contents after confinement must be immediately treated.

(3) Post-partum Hæmorrhage.—Post-partum hæmorrhage in cases of placenta prævia is a comparatively common occurrence. Its frequency is due to three factors:—

(*a*) Laceration of the Cervix.—This has been already noted.

(*b*) The Situation of the Placental Site.—When a large portion of the placenta extends below the contraction ring, its site cannot be affected to the same extent by the subsequent contraction and retraction of the uterine muscle as if the placenta was entirely situated in the contractile part of the uterus. As a result, the lumen of the placental vessels may not be completely obliterated.

(*c*) The Debilitating effect of previous Hæmorrhage upon the Patient.—Marked anæmia and debility, the results of previous hæmorrhages, have frequently a very prejudicial effect upon the uterine contractions.

Prognosis.—The prognosis in placenta prævia depends greatly upon the treatment adopted. The maternal mortality is said to vary between two, and forty per cent. Galabin had ninety-two cases, with eight deaths; Winckel, nineteen cases, with one death; Dührssen, fifty cases, with two deaths. Blacker has collected twenty-two cases, in which Champetier de Ribes' bag was used, with one death. At the Rotunda Hospital, where Braxton Hicks' method is used in all severe cases, eighty-six cases were treated from 1st November 1889 to 1st November 1900, with three deaths. Of the three deaths one was due to rupture of the uterus occurring in a case in which the forceps was applied. A second was due to hæmorrhage, the patient being admitted moribund, after a journey of five miles in an open cart. The third died of sapræmia, from which she was suffering when admitted. As in accidental hæmorrhage, the fœtal mortality is very high—from forty to sixty per cent.

FŒTAL MORTALITY IN ACCIDENTAL AND UNAVOIDABLE HÆMORRHAGE.—A few words must be said with regard to the fœtal mortality in these cases. It has been found by experience that the life of the child is, in ante-partum hæmorrhage, more or less antagonistic to the life of the mother, and that any treatment which will give the lowest maternal mortality will give the highest fœtal, and *vicê versâ*. *Accouchement forcé*, which in the past gave a maternal mortality of from forty to sixty per cent, gave a considerably lower fœtal mortality than does the treatment which is adopted at the present day. So far no treatment has been described which, while affording the same excellent maternal results that are obtained by Braxton Hicks' treatment in placenta prævia, or by vaginal plugging in accidental hæmorrhage, materially reduces the fœtal mortality. This condition of affairs is after all no more than must be expected. So far as we can see at present, it is necessary to give the mother as much time as possible, to recover from the hæmorrhage which has occurred, before the uterus is emptied either naturally or artificially. During this time, the fœtus is limited in its supply of oxygen to the amount which can come through a placenta, of which not only a large portion is detached, but of which the remainder is undergoing a more or less forcible compression against the uterine wall. If this compression can obliterate the vessels which are torn across, it must also to some extent diminish the size of the lumen of those which are intact. Furthermore, even if the fœtus is delivered alive, its expectation of life is extremely bad. It is frequently premature, and has always suffered more or less from deprivation of oxygen. As a result, such infants very frequently die during the first month after birth. Under these circumstances, the author considers that attempts should not be made to save the life of the child, if such attempts will materially affect the prognosis for the mother. It may frequently seem, in placenta prævia, as if a slight traction upon the leg of the child would save its life by hastening its delivery, and the very natural desire to save both lives may induce us to do so. In some cases, where the condition of the mother is good and the cervix is sufficiently dilated to remove the danger of laceration, it may be possible to hasten delivery without increasing the maternal danger to an unjustifiable extent. On the other hand, if the case is one which should have been left to nature—as the majority are—we may only find that we have sacrificed the life of the mother for the sake of an infant who succumbs shortly after its birth.

II. Hæmorrhage due to Rupture of the Uterus

Hæmorrhage always accompanies rupture of the uterus. Its amount varies according to the site of the laceration, the involvement or escape of the large uterine vessels, the amount of pressure exerted by the fœtal parts upon the laceration, the strength with which the uterus subsequently contracts, and the extent to which the neighbouring parts are implicated. The hæmorrhage may be internal, *i.e.* into the peritoneal cavity, or external, according to the site of the laceration, according as it is complete or incomplete, and according as the situation and nature of the presenting part prevents or permits the escape of blood. The symptoms are those of internal or external hæmorrhage, as the case may be, with the addition of the more direct symptoms due to the laceration itself (*vide* the articles on "Rupture of the Uterus," Labour, "Injuries during," vol. vi. p. 295).

2. Arising independently of the Pregnancy

MENSTRUATION

The possibility of menstruation occurring during pregnancy is a question which apparently has not been definitely decided. In answering such a question much depends upon the definition we attach to the word menstruation. If the latter is understood to mean merely a periodical discharge, there is apparently no reason why it should not occur. Undoubtedly the uterus undergoes some form of stimulation, even during pregnancy, at what would have been the menstrual periods if the patient had not been pregnant. Under such circumstances, it is not very difficult to believe that the attendant congestion may cause a slight hæmorrhagic discharge from an ulcerated cervix, a polypus, or even from the inflamed decidua vera covering the lower pole of the uterus before this membrane has come into contact with the decidua reflexa, that is, before the third month. If, however—as is the more correct definition—we consider the term to be applicable only to the physiological discharge which accompanies the monthly destruction and expulsion of the uterine endometrium, it is obviously impossible that menstruation could take place during pregnancy without causing abortion. The cases of supposed menstruation during pregnancy can almost invariably be accounted for by some pathological condition of the uterus or cervix. The regular occurrence of a monthly discharge during the whole of pregnancy points almost invariably to the existence of a double uterus. Pajot says that, while the hæmorrhagic discharges which occur during pregnancy may have some characters which cause them to resemble menstruation, they invariably differ from the latter in their duration, and in the quantity and quality of the blood. Pinard states that there has never yet been observed a single case of the persistence of menstruation in a pregnant woman. Dakin considers that, "while one monthly bleeding may be allowed to pass as a menstruation in the absence of any discoverable cause, or of any further disturbance, any repetition of this should always be looked upon as a threatening of abortion, and the patient treated on this assumption."

American authorities, on the other hand, do not regard the persistence of menstruation as so impossible or improbable. Lusk considers that the occurrence of pregnancy is not incompatible with the existence of a periodical flow—to which, however, he is careful not to apply the term menstruation. Parvin states that a monthly flow may occur once or oftener during pregnancy, or even persist during the whole period. While Palmer of Ohio records the case of a patient of his own who never menstruated except when she was pregnant!

The general attitude of modern authorities, in the case of patients who consider themselves to be pregnant while they are still menstruating, may be summed up in the words of Stoltz: "Rarely will one be deceived who regards a woman menstruating regularly, with all the characters of menstruation, as not pregnant; while trusting the contrary opinion, he is exposed to frequent errors."

HÆMORRHAGE FROM TUMOURS

Myomata.—Myomata of the uterus generally cause sterility, and consequently are not a very frequent complication of pregnancy. Intra-uterine myomata may, during pregnancy or labour, give rise to accidental hæmorrhage by causing the detachment of the placenta, owing to the irregularity their presence imparts to the uterine contractions. Subsequent to delivery they are a very common cause of post-partum hæmorrhage. Myomata of the cervix, or pedunculated myomata of the uterus which project into the vagina, may give rise to constant small hæmorrhages during pregnancy, and have been found as the cause of those periodical discharges which simulated menstruation.

Treatment.—For the treatment of myomata of the body of the uterus complicating pregnancy, the reader is referred to the article on these tumours. Small or large polypoid myomata projecting into the vagina or cervical canal must be twisted away, or cut away according as is necessary. The constant hæmorrhagic discharge which they cause weakens the patient; there is a great risk of their being deprived of their blood supply and sloughing, and they may offer an obstruction to the delivery of the child when labour comes on. There is little or no risk of their removal causing the onset of labour.

Malignant Disease.—Malignant disease of the cervix or vagina will cause a more or less continuous hæmorrhagic and perhaps sanious discharge during the whole of pregnancy. It will also favour the occurrence of abortion owing to the anæma and cachexia it induces. The rapidity of its growth is very marked during pregnancy, while after the expulsion of the fœtus there is a temporary check.

Treatment.—If the existence of malignant disease is determined in the early months of pregnancy, abortion ought to be induced, whether the case is one in which a radical operation is possible, or whether it is not. In the former, the induction of labour is a matter of course; in the latter it should be performed in order to check the otherwise rapid growth. If the patient is in the later months of pregnancy, and the radical removal of the growth is possible, labour ought to be induced irrespective of the condition of the fœtus. If the growth is inoperable, and our decision lies between the extraction of a premature or immature fœtus through the vagina, or a full-term fœtus by Cæsarean section, we must be largely or entirely influenced by the wishes of the patient. In a case in which we determine to wait, a temporary check may be given to the discharge by curetting away any very prominent masses which project into the vagina, and by careful cauterisation.

Other tumours or pathological conditions, whose existence may give rise to slight hæmorrhage coming from the vagina or its neighbourhood during pregnancy, are urethral caruncle, mucous polypi of the cervix, and hæmorrhoids.

HÆMORRHAGE FROM TRAUMATISMS

Traumatisms in the region of the vagina and vulva will cause a varying degree of hæmorrhage, according to the nature of the lesion. Their treatment is similarly influenced. Considerably more interesting than the immediate effect of such injuries is the question of the result of a traumatism, either surgical or otherwise, upon the pregnancy. So far, the most varying consequences have been met with. In some women, a very severe accident or surgical operation has been attended by no bad effects upon the pregnancy. In other women, the slightest accident or interference has been followed by the immediate emptying of the uterus. Guéniot's conclusions on this subject are as follows:—

(1) The harmlessness of traumatism in pregnancy is not governed by any absolute law.

(2) A traumatism, if the woman is without morbid predisposition—she, her uterus, and the ovum healthy—is generally without injurious effect upon the pregnancy.

(3) If gestation is complicated by a pathological condition, such as abnormal irritability of the uterus, disease or great size of the ovum, albuminuria, etc., the traumatism, however slight, and whatever the part involved, most frequently causes premature expulsion of the ovum.

(4) Great caution is necessary in performing surgical operations during pregnancy.

Ribemont-Dessaignes considers that accidental traumata vary in their effects, according to their intensity, their site, the amount of hæmorrhage which accompanies them, and the occurrence of wound complication, sepsis, etc. As regards surgical intervention Verneuil says: "Surgical intervention is not forbidden during pregnancy, but is under the guidance of a definite rule—to abstain from it when it is possible to do so; to intervene when it is necessary."

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Presbyopia. *See* REFRACTION.

Prickly Heat. *See* SKIN—SECTION DISEASES OF TROPICS.

Proctitis. *See* RECTUM.

Progressive Muscular Atrophy. *See* MUSCLES, PARALYSIS.

Prolapsus. *See* PELVIC FLOOR. RECTUM.

Prostate Gland, The.

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THE *anatomy* of the prostate gland may be briefly referred to. It is a firm, glandular and muscular organ, weighing a little over half an ounce. About the size and shape of a horse-chestnut, it surrounds the neck of the bladder and the commencement of the urethra in the male. Placed in the pelvic cavity, its base is directed backwards towards the neck of the bladder, while its apex presents forwards. The posterior and larger surface rests upon the rectum, while the anterior and smaller surface is flattened, and is marked by a slight longitudinal groove. The prostate is divided into three lobes—two lateral lobes and one middle—which up to adult life is hardly perceptible. It is perforated by the urethra and the common seminal ducts. The prostate is enclosed in a dense fibrous capsule, which is continuous with the recto-vesical fascia and with the posterior layer of the triangular ligament. The substance of the gland is of a pale reddish grey colour, very dense and friable. In structure it is a compound organ, being partly muscular and partly glandular. The muscular elements are of the involuntary kind, and are arranged so as to form an external layer within the fibrous capsule; circular bands also surround the urethra, while fasciculæ extend in all directions through the glandular substance. The adenoid tissue is composed of numerous small saccules, and these opening into elongated canals terminate in excretory ducts, numbering in all from twelve to twenty. These open upon the floor of the urethra, on each side of the colliculus seminalis.

Physiology.—Possessed of two distinct histological elements, the gland has a double function to perform. The glandular structure secretes a milky acid fluid which lubricates the urethra prior to the venereal orgasm, and also forms a portion of the discharge emitted during the sexual act. Its function is like that of the secretion of the vesiculæ seminales, namely, to dilute the seminal fluid, and so, by increasing its bulk, more efficiently convey the semen within the female passages. The muscular elements not only cause the prostatic secretion to be exuded, but also simultaneously assist in expelling the semen from the seminal ducts.

(*a*) *Injuries* of the prostate, except by instruments introduced along the urethra, are not common. The gland may be punctured or lacerated by falls, or by being impaled on spikes entering from the perinæum, or by surgical wounds; but the situation of the gland, deep in the perinæum, as a rule protects it from direct violence. After middle life, on account of the enlargement of the middle lobe, the prostate is liable to injury by the passage of a catheter. This circumstance should always be kept in view, as not infrequently the enlarged lobe is soft and friable, and the employment of force in the use of a metal catheter may readily lead to perforation of this lobe. The *symptoms* of such an injury do not appear immediately, but a few hours after its occurrence the patient may complain of the symptoms of retention of urine, and repeated attempts to empty the bladder may fail to give relief, a few drops of blood only escaping by the urethra. Reintroduction of the catheter may do little good. A small quantity of urine with blood-clot alone coming away. The distension is not reduced, and if prompt measures are not taken symptoms of toxic poisoning rapidly set in, and steadily increase. The tongue becomes dry and rough, the pulse full, rapid, and compressible, respiration is accelerated, the temperature rises, the skin becomes hot and flushed, and the lips livid.

Treatment.—The distension of the bladder must be relieved at once, not by the passage of instruments through the injured urethra, but by supra-pubic incision, with free drainage and irrigation. In wounds from without bleeding may be severe, and demand active treatment. In such cases, provision having been made for the free escape of urine either through a catheter or by supra-pubic incision (but not otherwise), the perineal wound may be plugged. Or the wound may be enlarged and the vessels ligatured. Under no circumstances should sutures be used to close the wound, as such treatment is certain to promote sepsis.

(*b*) 1. *Inflammation of the Prostate* (*Acute and Chronic*).—*Acute prostatitis* arises as a secondary infective process in cases of acute inflammation of the bladder or of the urethra. The most common direct causes are inordinate sexual excitement, gonorrhœa, and gleet, and when due to gonorrhœa the symptoms of involvement of the prostate most usually appear about the fifteenth day. The other causes are the employment of strong injections, the internal administration of irritating drugs, the passage of instruments, the presence of foreign bodies, or of calculi, and mechanical violence applied to the perinæum. The inflammatory process may be checked, or it may go on to suppuration and abscess.

The *symptoms* are frequent and urgent, desire to make water, and after micturition the pain, in place of being relieved, is rather increased. It becomes very severe, throbbing, and continuous. The perinæum is hot and tender, there is rectal tenesmus, and pain in the back and loins. Any movement of the bowels causes distress, the anus is swollen, and large hæmorrhoids forming, add materially to the suffering of the patient. Retention of urine, necessitating the employment of the catheter, causes excessive pain. Constitutional disturbance is very marked, and even suppression of urine may be induced in the later stages. The onset of suppuration is indicated by rigors, and its actual occurrence demonstrated by the appearance of pus in the urine; the portion which comes away first containing pus, while in the last few drops blood appears.

Prognosis.—When acute prostatitis is properly treated, and abscess formation is prevented, recovery usually takes place in a short time, but in a few instances the disease may become chronic, and give rise to chronic urethral discharge.

The bowels having been freely moved with four grains of calomel and a saline, the subsequent *treatment* consists of rest, local bleeding, and hot applications to the perinæum. Absolute rest in bed must be enjoined, and from ten to twenty leeches should be applied to the perinæum, which has been previously shaved and thoroughly cleansed. Local bleeding, if carried out *freely*, gives marked relief. Four hours after the bleeding the patient should be ordered a hot hip bath, and this may be repeated every four hours, and during the intervals large soft poultices should be applied to the perinæum, and the patient wrapt warmly in bed. If the pain is very severe a morphia suppository may be given, and if retention of urine occurs, a soft Coudée catheter may be gently passed.

Chronic Prostatitis.—In cases of acute inflammation of the gland the inflammatory products may fail to be absorbed, leaving behind a permanent enlargement of the organ, producing painful and frequent micturition. This form of enlargement is met with in young adults or men in middle life, and is sometimes accompanied by sexual hypochondriasis, and diminished power to expel the urine from the bladder. The urine usually contains muco-purulent shreds, and at the end of the flow a few drops of blood may escape. Examination *per rectum* generally shows some enlargement or tenderness of the prostate, and on the introduction of the bougie into the urethra the passage is found to be unduly sensitive, and before the instrument enters the bladder it meets with a distinct sense of resistance in the situation of the neck. The *treatment* consists of the passage of steel bougies, the use of injections, the application of counter irritants, and the administration of tonics. A number twelve Lister's steel bougie should be passed morning and evening. This treatment should be kept up for six weeks if necessary, and at the same time small blisters should be applied to the perinæum. If in this time no distinct improvement has taken place, a solution of nitrate of silver (4 per cent) may be applied to the prostatic urethra, through the endoscope, or other efficient instrument. Three or four such applications may be required. Constitutional treatment must also be employed. In persons of full habit, four grains of blue pill may be given twice a week, and followed by a saline, and a course of tonic treatment should also be recommended. Iron, arsenic, and quinine may be prescribed, and along with good plain diet, pure air, moderate walking, but no riding exercise, and abstinence from all kinds of excitement generally effect a cure.

2. *Periprostatitis.*—In acute inflammation of the gland the infective process may extend to the periprostatic cellular tissue, and when this occurs the disease generally goes on to suppuration, but in a few instances the disease involves the tissue around the prostate in the first instance, and only invades the gland later on.

3. *Abscess of the Prostate.*—Whether or not acute prostatitis culminates in abscess depends upon the virulence of the infected material, the constitutional resisting power of the individual attacked, and the treatment adopted by the surgeon in the early stages of the malady. When left to nature acute prostatitis may result in the formation of an abscess within four days of the onset of the symptoms, or suppuration may be delayed for ten to twelve days. The most prolific cause of abscess is the misuse of the catheter. The formation of an abscess may be suspected when the symptoms of acute prostatitis become suddenly aggravated, accompanied by rigors and a distinct rise in temperature. When the abscess has formed fluctuation may be felt per rectum or by pressure on the perinæum. However gently the examination may be conducted it causes the patient great pain. Much suffering is also occasioned during micturition and defæcation.

The abscess if left alone may rupture in one of several directions. The pus may infiltrate the perinæum and rupture externally or into the rectum; it may escape by the urethra, perforate the wall of the bladder, or penetrating outside the walls of that viscus it may evacuate itself into the cavity of the peritonæum.

Symptoms of acute abscess have been already indicated, but those of *chronic* abscess are often insidious in their onset, and the progress of the disease is slow. Not infrequently the suppuration arises in old neglected cases of stricture of the urethra in cases where the prostate is hypertrophied or where the catheter has been improperly used. Prostatic calculus may also excite the formation of chronic abscess. *Prognosis.*—In acute abscess the outlook is usually favourable, but the formation of a chronic abscess is always a serious matter, and may lead to complete destruction of the gland, which is replaced by a pus-forming sac, and the patient suffers from fever, emaciation, and not infrequently exhaustion from septic poisoning aids to a fatal termination. The *treatment*, as soon as fluctuation can be made out, is free incision in the middle line and drainage. Small incisions opening into the bowel, or aspiration, deserves and meets with no success.

4. *Urinary fistula* not infrequently follows the opening of a chronic prostatic abscess, especially if the patient has an old urethral stricture. These fistulous openings are often difficult to heal. The first indication as to treatment is to relieve the stricture, and when this has been accomplished the patient should be taught to use a soft rubber catheter at regular intervals until urine ceases to escape by the fistula.

(*c*) *Atrophy of the prostate* is occasionally met with in old age, and in those in which the sexual desires are feebly developed, in eunuchs, and in those who have been deprived of their testicles by disease. The condition does not give rise to any symptoms, and is of little surgical importance.

(*d*) *Hypertrophy of the prostate* pertaining to old age is by a long way the most common and the most important lesion of the prostate met with in surgical practice. Clinically, the enlargement of the gland is the important fact. The special structural features are of secondary concern. The enlargements of the prostate in those of advanced years have been divided pathologically according to the structural changes observed. By far the most serious change in old age is the increase in the muscular elements, together with fibrosis of the organ. This hyperplasia exists in about 30 per cent of men over 60 years old, and is seldom met with in those under the age of 50. Not only may the muscular structures increase in bulk, but in a few instances there may be also an augmentation of the glandular, so that we may have an adenoma of the prostate. The lesion of old age is a fibrosis and muscular hyperplasia in almost all cases.

A true hypertrophy is unknown, but as in all glandular organs so also in the prostate, occasionally adenomata may be found. In so-called "hypertrophy" of the prostate the progress of the disease is slow, and as a rule those who have led sedentary lives are more liable to an attack, but beyond this fact little is known regarding the etiology of the malady. Many predisposing causes have been named,—syphilis, urethral stricture, gout, rheumatism, vesical calculus, etc.,—but their influence as etiological factors has not been proved, beyond the circumstance that they induce a passive hyperæmia of the lower urinary tract. It is a circumstance worthy of note that men who have been deprived of their testicles by operation, accident, or disease, never have enlarged prostates. This enlargement of the prostate differs from hypertrophy of all other organs excepting the uterus in the fact that the onset does not coincide with the period of greatest functional activity of the gland, and an increase in bulk is not due to an augmentation of its active elements. Structurally, the change in many respects resembles a fibrosis due to passive hyperæmia, and therefore is comparable to the analogous enlargement of the uterus (fibro-myoma). The prostate may enlarge uniformly and attain considerable dimensions without causing much discomfort to the patient. On the other hand, without any great general enlargement, there may be a local increase in bulk of the middle lobe only. The effects of this are sometimes very marked. The middle lobe projects upwards, at the neck of the bladder, and may act like a valve to the orifice of the urethra. Or the urethra may be pushed upwards and forwards so that on section the canal is of crescentic form with the concavity looking downwards. When the hypertrophy is general the prostatic portion of the urethra, which nominally measures 1½ inches, may be extended in length to 4 inches, and the weight of the gland from being a little over half an ounce may be increased to 10 ounces. When the prostate weighs more than 7 drachms it may be described as abnormal in size.

The *symptoms* of hypertrophy of the prostate depend upon the nature and the position of the new formed tissue. When the hyperplasia uniformly involves the whole organ a considerable period may elapse between the onset of the disease and the evidence of its presence. While on the other hand if the growth involves the middle lobe only, there may be the occurrence of marked symptoms before much enlargement of the gland can be made out by digital examination *per rectum*. The first indication of increase in the size of the prostate gland is a diminution in the force by which the urine is expelled, then micturition becomes more frequent, and the relief given by the act is incomplete. Should any undue accumulation occur, as after prolonged sleep, or after taking a large amount of stimulants, the bladder finds difficulty in expelling the accumulated urine. In place of being emptied by one act frequent calls are made within a short period, and even the repeated efforts are not altogether successful. The inconvenience arising from frequent micturition and incomplete relief after the act in voiding the bladder are at first trivial, but as the obstruction increases the functions of the bladder become more and more impaired, in spite of a compensatory hypertrophy of the muscular wall of the bladder developed in order to increase the expulsive force. Sleep is disturbed by frequent calls to pass urine, the efforts to micturate become more ineffective, and the relief to the bladder less complete. That viscus gradually becomes dilated, and habitually fails to empty itself, a portion only of its contents being expelled at each act of micturition; the patient complains of obscure pains in the perinæum, the rectum, and the neck of the bladder. In some instances the pain may extend down one or other great sciatic nerve, he observes that the stream of urine becomes smaller, and the force by which it is expelled gradually less. Micturition does not commence at will, increased efforts occasionally cause escape of the contents of the bowel. As a consequence of continued straining of the parts hernia, hæmorrhoids, or even prolapse of the rectum may be induced, and passive hyperæmia resulting from increased resistance to the venous return may cause erections unassociated with sexual desire.

If these difficulties consequent upon interference with the mechanism of micturition are not relieved by art, the pressure which has been exerted to void urine induces dilatation of the bladder, and in old-standing cases may cause sacculation of that viscus. Bi-lateral hydronephroses and dilatation of the ureters follow as a natural consequence of the pressure being reflected backwards, but the distension is not always equal on the two sides. On account of these structural changes the functions of the bladder and kidneys show evidence of failure. The bladder remains habitually filled, only the surplus urine escaping at micturition. During the unconsciousness of sleep, to the patient's great discomfort, the urine passes more freely, and he is said to be suffering from "incontinence," a term which may be used if its exact clinical significance is appreciated, but it is essentially faulty in the sense that it does not describe the condition present. The bladder contains too much urine, the "incontinence" only applies to the overflow. The patient's general health steadily deteriorates, and if left unrelieved by surgical treatment acute and critical symptoms may develop at any moment, and may be induced by the most trivial cause. Long-standing urinary embarrassment renders the organs involved specially liable to septic infection, which may take place independently of the use of instruments. But the fact cannot be overlooked that in many instances the symptoms of toxic poisoning closely follow upon the first use of the catheter. After sepsis has been induced the natural course of events is usually very rapid. Let it be accepted that the patient has not been relieved by the surgeon in the early progress of the disease. The prostatic obstruction that induced hypertrophy of the walls of the bladder in the early stage, as the disease advances, also causes dilation and atrophy of the muscular elements. Following there may also be sacculation of the bladder, dilatation of the ureters and pelves of the kidneys. The urine is acid, pale in colour, deficient in urea, and may contain a little albumin. The patient is feeble, his appetite is poor, and his urinary troubles are as they have been for months. After drinking rather heavily, or after returning from a fatiguing journey, he becomes "chilled," and goes to bed. Early the following morning he finds that he is unable to pass water, and no relief follows the remedies he is accustomed to use. Retention of urine is complete, and for the first time a catheter is passed. In the afternoon and evening he has several severe rigors, his temperature rises rapidly, the pulse is full, bounding, and rapid, the respirations are shallow and augmented in number, the tongue is dry and the lips parched. The skin is moist and soft, the urine now drawn off, in place of being clear and acid, contains some blood, is slightly opaque, and has a pungent odour. Next morning the urine is distinctly alkaline, and contains urea-decomposing organisms, such as staphylococcus pyogenes aureus, and S. pyogenes albus. The tongue becomes dry and brown, the skin pale in colour, the quantity of urine secreted is diminished; later on diarrhœa sets in, the patient's temperature rises to 102° or 103° F., and then follow the symptoms of suppression of urine with septic intoxication.

When septic infection occurs at an earlier stage in the disease the progress of events is not so rapid. The symptoms point to subacute cystitis with decomposition of urea prior to evacuation. (See "BLADDER," vol. i.) The urine from being clear and acid in reaction slowly becomes turbid. The reaction passes from acid to neutral, then gradually becomes alkaline, offensive in odour, and later on distinctly ammoniacal. Symptoms of cystitis slowly develop, and the urinary difficulties steadily increase, the inflamed bladder being less able to contend with the urethral obstruction. Infection gradually extends from the bladder to the ureters and kidneys. The general health becomes steadily impaired, slight feverish attacks occur at intervals, and toxic poisoning from septic infection and suppression of urine bring about the end.

The *diagnosis* in the early stage of the disease should depend entirely upon a careful consideration of the symptoms, and a digital examination of the gland through the rectum. This can be done, in the first instance, without the employment of a bougie or sound passed into the urethra.

Familiar with the palpation of the normal prostate as regards situation, size, form, and consistence, the surgeon can readily detect by the finger alone a departure from health. On pressing the finger forwards in the middle line in place of the soft yielding coats of the bladder he finds in hypertrophy of the gland a distinct firmness. Then examining to right and left he can ascertain whether or not the hypertrophy is limited or general, or regular or uniform, whether it is solid or contains fluid. The degree of pain and discomfort which the examination occasions is an important guide. In hypertrophy, unless when there is some rectal complication, the suffering is slight, whereas in enlargement due to inflammation, to malignant disease, or to tuberculous affections, extreme pain will be caused by the pressure of the finger. In acute inflammation the introduction of the finger will be resisted, and the parts will be found soft and heated as well as swollen. The prudent surgeon will avoid examination with the bougie as long as possible, unless symptoms of stone in the bladder demand attention, or the history of the case points to cicatricial stricture of the urethra. In the latter condition the obstruction is lower down than in that produced by an enlarged prostate. It is encountered within 7 inches of the meatus, whereas in hypertrophy the obstruction is beyond 7 or 8 inches, and before a sound can reach the bladder the handle must be deeply depressed between the legs of the patient; moreover, cicatricial stricture is most frequently found in the membranous portion of the urethra, and occurs before or during middle life. In vesical calculus the pain is more severe, is increased at the end of micturition and by active exercise or jolting, diminishes by rest in bed, and is associated with frequent hæmaturia. In calculus the pain and frequent micturition are most troublesome during the day, whereas in hypertrophy of the prostate the urinary difficulties are most marked at night. Phosphatic calculus and enlarged prostate frequently coexist, and the use of the sound can alone clear up the diagnosis. Vesical tumours are attended by intermittent and unprovoked attacks of severe hæmaturia, and in the early stage of the disease not preceded or accompanied by pain unless clots form and obstruct the escape of urine. Fragments of the tumour may be discovered in the urine. In the later developments of the malady the tumour may come to involve the neck of the bladder and impede the passage, pain then becomes a prominent symptom. Examination *per rectum* usually clears up the diagnosis. In malignant disease the swelling is less regular in form, and occasions the patient much pain. Hæmaturia becomes profuse and continuous, anæmia becomes marked, and rapid emaciation occurs, and the inguinal lymphatic glands become enlarged.

In atony of the bladder retention is the marked symptom, but here the catheter passes without meeting with obstruction, and rectal examination shows that the prostate is not enlarged. This is also observed in paralysis of the bladder, but it is always associated with paralysis of the lower extremities.

With respect to *treatment* one important fact must be accepted, namely, that its success or failure depends upon the disease being recognised early and promptly treated. As soon as the enlargement of the prostate prevents the patient from completely emptying his bladder his "catheter life" should begin. The catheter, when used thus early, is a safe and useful instrument, but when its employment is delayed until secondary changes have taken place in the bladder and kidneys, however careful the surgeon may be, its use is attended with much danger. It is often very difficult to make a patient understand that the habitual use of the catheter is necessary in the early stages. The only troubles he has are frequent micturition, a sense of imperfect relief, and some feeling of weight and tenderness at the neck of the bladder. To relieve this, is he to submit himself to the regular use of the catheter? Yes, certainly. Not simply to promote his immediate comfort, but rather to save him from the otherwise inevitable distressing complications which follow unrelieved prostatic obstruction. The treatment must be regulated according as the secondary complications are just beginning or are advanced. Take the former instance first. The patient, a man over fifty years of age, consults the surgeon and complains of frequent micturition and imperfect relief after the act; he has some pain occasionally, but it is never distressing. His general health is good, and beyond the urinary symptoms he has little to complain of. After satisfying himself by a rectal examination that the prostate is enlarged, the surgeon must next ascertain if the bladder is being completely emptied, and this can only be done by passing a catheter. To do this safely certain precautions must be taken in the first instance, that is to say, until the amount of the residual urine is known. To begin with, the surgeon should avoid making an examination in his consulting room. Send the patient home with instructions to go to bed, and when the surgeon visits him the patient is instructed to pass as much urine as he can by natural effort, then all precautions having been taken to avoid sepsis, a soft gum-elastic catheter is gently passed while the patient is in the erect posture. The quantity of water (residual urine) which comes away is a tolerably safe guide in estimating the stage of the disease and the secondary complications to which it has given rise. The patient should be ordered 2 grains of quinine, a hot hip bath, and be instructed to remain in bed till he is seen by the surgeon on the following morning. How often the catheter will require to be used depends upon the amount of the residual urine, but, as a rule, it is well to completely empty the bladder every evening at bedtime. On the other hand, suppose the patient has not sought surgical advice until the disease is far advanced and complete retention has occurred, the method of procedure is somewhat different, and the risks involved are much greater. The greatest care must be taken against septic infection, as all the conditions favourable to rapid invasion are present in the urinary tract. The distended bladder must be emptied very slowly. This can be carried out by a syphon arrangement, by which only 2 or 3 ounces of urine are permitted to escape per hour. The bladder should in this way be completely emptied in twenty-four hours, when the catheter may be withdrawn, unless great difficulty was experienced in introducing it from irregularities of the urethra or from false passages. These circumstances, therefore, alone justify tying in a catheter. The practice, although often convenient for the surgeon, greatly increases the danger of sepsis. In cases where the retention is sudden or attended by acute symptoms, suprapubic drainage must be resorted to. Suprapubic aspiration may be useful occasionally in order to render temporary relief.

The medical treatment consists in the administration of mild laxatives, careful regulation of diet, and the administration of boracic acid or urotropin may be resorted to if there is a tendency to the urine becoming alkaline or if septic infection has occurred. In the latter instance it may also be necessary to wash out the bladder regularly with a mild antiseptic solution, and after the bladder has been cleansed, a drachm of a solution of nitrate of silver (2 per cent) may be introduced and allowed to remain. The patient should be instructed to avoid horse-riding, excess of food or alcohol, sexual excitement, sudden changes in temperature, or undue fatigue.

Radical treatment may be carried out in three different ways by—

(1) Castration.
(2) Vasectomy; and
(3) Prostatectomy.

The relationship of the growth of the prostate to the condition of the testicles has been referred to already, and the analogy between uterine fibromyoma and prostatic enlargement has also been pointed out. Keeping these points in view and noting the effect that the operation of oophorectomy has in reducing the size of the uterine fibroid, Professor White of Philadelphia was the first to suggest *castration* with the view to produce atrophy of the enlarged prostate, and thereby restore to natural micturition. Although this method of treatment has been successful in a few instances, it has not proved itself to be uniformly so, and in a certain proportion of cases serious mental derangement has followed complete castration, in some instances amounting to helpless imbecility. In order to avoid the possibility of such a calamity the operation of vasectomy has been proposed and carried out by Guyon and Harrison. The operation is devoid of risk, and the results are said to be satisfactory.

Ligature of the arteries supplying the testicles not only cause atrophy of these glands, but it also induces a decrease in the size of the enlarged prostate. For the operation of vasectomy general anæsthesia is not required, cocain is sufficient. The vas deferens is easily isolated by the finger as it enters the abdominal ring. At this point an incision is made and the vas exposed to view. Each cord should be divided and ligatured, and the whole operation should be performed with as little disturbance to the parts as possible, and with strictly aseptic precautions. The patient is often very restless, liable to displace the dressings and contaminate them with dribbling urine, so it is well to carefully adjust the edges of the wound with sutures, and seal with collodion in addition to dressings applied. The writer has found this mode of treatment very successful, especially in cases of rapid enlargement of the prostate.

Excision of the prostrate in whole or in part for the removal of prostatic obstruction and preservation of the expulsive power of the bladder has not proved very successful. Whether prostatectomy is or is not a justifiable operation has been gravely questioned by many surgeons, while only a few advocate its use. Certainly it should not be employed except in cases which have proved intractable to careful and prolonged catheter treatment, and considering the high mortality which attends the operation it should not be undertaken without the patient's knowledge of the risks involved.

The cases which are suitable for prostatectomy are those in which the enlargement is intravesical rather than rectal, and certainly the most favourable of all cases are those where a more or less pedunculated outgrowth has formed in the middle lobe. In such cases prostatectomy is an operation of value, but in sessile growths and in annular formations surrounding the neck of the bladder like a collar little good can be expected from an operation. How is the surgeon to know the exact condition present? A cystoscopic examination is almost impossible, the alternative is suprapubic incision, but this can be employed only when the bladder is free from cystitis and capable of distension.

Much has been written on the relative advantages of the perinæal, the suprapubic, and the combined methods. The first-mentioned has the drawback of giving very little room, and the operation requires to be performed almost entirely in the dark; but, on the other hand, it affords good drainage, it alone is applicable to cases of chronic cystitis with contracted bladder, and it is the most suitable operation when the patient is feeble and a prolonged procedure is inadvisable.

In those cases where the bladder can be well distended the suprapubic operation should be employed. It is a safe one, and should the surgeon fail to reach the growth from the front he may resort to the combined method. Opening the bladder in front the interior of the viscus may be explored by the finger, and at the same time, using a forehead mirror, reflected light enables the parts to be clearly seen, and admits of the operation being performed with precision and completeness. When the enlargement of the prostate is due to a passive hyperæmia free suprapubic drainage alone gives marked relief; the functional activity of the bladder being placed in abeyance the nutritive activity of the parts also becomes lessened, and marked diminution of the gland may result.

(*e*) *Simple tumours of the prostate* are very rare. They include the myomata and adenomata. The former resemble in appearance hypertrophy of the gland, and differ in the circumstance that the growth is not limited to those of advanced years. The true adenomata of the prostate is encapsuled and occurs mostly in young men.

(*f*) *Malignant tumours of the prostate*, "carcinoma" and "sarcoma," affect the two extremes of life, childhood and old age. They as a rule appear before the seventh year or after the sixtieth year, but are very rare either as primary or as secondary formations. In childhood the disease is generally sarcomatous in its nature, its growth is usually very rapid, the course of the malady seldom extending over eight or nine months. The carcinomata, on the other hand, are more prevalent in old age. This lesion primarily attacks the glandular structures in one lobe, and from the original centre rapidly spreads until the whole gland is displaced by the morbid growth. It may then rupture the firm fibrous capsule of the prostate and invade the surrounding tissue. This is, however, seldom the case, as usually when left to nature the urinary symptoms are so severe that the patient succumbs before that stage is reached. The symptoms of malignant disease in children are so characteristic that there is little difficulty in distinguishing it from other maladies, but in the disease as it attacks the aged the inexperienced surgeon is apt to be misled. In children the marked feature is persistent and steadily increasing hæmaturia, the blood coming away most copiously at the end of micturition, often at first unassociated with pain, but as the disease advances symptoms of diminished expulsive power combined with those of cystitis declare themselves. In the malignant disease of old age the early symptoms are so similar to those of ordinary hypertrophy that there is much danger of the rarer malady being mistaken for the commoner one. In malignant disease, however, hæmaturia and pain are early symptoms, and the latter is independent of obstruction to the escape of urine. The course of the disease is very rapid, and on rectal examination a hard nodulated mass, which is very tender to the touch, can be detected. Soon the tumour softens and fungates, the urine presents a peculiar, disagreeable odour and becomes septic. Acute cystitis is set up, hæmorrhages are more frequent and more profuse, the symptoms of obstruction rapidly develop, the sufferings of the patient are intensified day by day, anæmia and emaciation become marked, and the patient gradually sinks from exhaustion or dies from toxic poisoning.

Treatment is only palliative, to remove the tumour with success is practically impossible. The administration of opiates in some form, and suprapubic drainage give relief to pain and prolong life.

The suprapubic operation is best performed in two stages. The bladder being first stitched to the abdominal wall, and a few days later when adhesions have formed, the viscus can be opened and a tube inserted. Catheterism gives rise to great suffering and much bleeding.

(*g*) *Tuberculosis of the prostate* is secondary always to similar diseases of other parts of the urinary tract, the kidneys, the bladder, or the vesiculæ seminales, being primarily affected; or it may be due to an infected thrombosis from tuberculous disease of the lungs, of the joints, or of bones. The disease is met with most commonly in early adult life; the morbid process in the prostate being similar to tuberculosis elsewhere. To begin with, the tuberculous infiltration involves one lobe only, and for some time may not produce any very noticeable enlargement, but as the disease extends inflammatory œdema sets in and causes an increase in the swelling. The infiltration is followed by caseous necrosis, which gradually extends towards the mucous membrane of the bladder or bowel. The mass breaks down, the deep, excavated ulcers form, and perforation takes place into the bladder or bowel, or into the ischio-rectal fossa or the peritoneal cavity. These ulcers act as centres of septic infection and rapidly lead to a fatal termination. The *symptoms* during the early stage are not characteristic, especially when the disease attacks the peripheral parts of the gland. Indeed, the onset of the disease is liable to be overlooked, but its presence should always be suspected when a patient suffering from a strumous enlargement of the epididymis or a tuberculous kidney complains of a weight in the perinæum and rectal tenesmus. The diagnosis may be confirmed by the occurrence of occasional slight hæmorrhages, by the discovery of tubercle bacilli in the urine, and by the presence of an enlarged prostate. The enlargement may consist of one or more isolated masses embedded in the substance of the prostate, or may be due to a general increase in the whole gland. As the disease advances the symptoms become unmistakable. The urine becomes muco-purulent, hæmaturia is a frequent sign, and gradually, as the new formation encroaches upon the neck of the bladder, the symptoms of prostatic obstruction become more marked, and may culminate in complete retention.

The *diagnosis* in the early stages may be difficult in some instances, but during the later developments little difficulty should be experienced. Frequent and painful micturition in a strumous subject associated with occasional hæmaturia, in the absence of vesical calculus, is a strongly suspicious circumstance, and if in those conditions we have muco-purulent urine containing tubercle bacilli, and a painful swelling at the neck of the bladder in a man between 20 and 40 years of age, the diagnosis of tubercular disease of the prostate may be made with confidence.

The *prognosis* must depend upon a careful consideration of the whole circumstances of the case, the nature and extent of the primary disease, as well as that of the local lesion. Most of the cases run from bad to worse, and acute sepsis of the urinary tract brings about its inevitable termination.

Treatment.—When the local disease is limited and the general constitution good, which it very rarely is in these cases, surgical interference may be justifiable. Some surgeons advocate incising the gland, scraping away the tuberculous material, and packing with iodoform gauze, and no doubt in a few instances this treatment has been remarkably successful. The use of lactic acid and other agents has been advocated, while considerable benefit is also said to be afforded by the injection into the bladder of an emulsion of iodoform in olive oil, three or four times a day. The use of instruments passed into the bladder is to be avoided, as they merely cause irritation and aggravate the disease. In the more severe cases local treatment is practically limited to alleviating suffering by opening, scraping out, and draining the tuberculous abscess, and by administering narcotic drugs in the form of suppositories. Of the constitutional treatment nothing need be said.

(*h*) *Cystic diseases* of the prostate are very uncommon. Of retention cysts there are two varieties: (1) those due to obstruction of the excretory duct of the prostatic follicles, and (2) those caused by closure of the orifice of the sinus pocularis. Besides these there are hydatid cysts which are not strictly prostatic, having their origin in the tissues between the bladder and rectum, rather than in the substance of the gland. By their proximity they may closely simulate prostatic enlargement. These cystic conditions are of pathological interest, but not of much clinical importance, except in so far as concretions are liable to form in them.

(*i*) *Prostatic concretions* are very common in old persons. When small in size and of recent formation they are pale in colour, but if large and old they are reddish brown or black. They vary in size, some being very much like rounded grains of sand, while others may be as large as poppy seeds. They are round or oval in form, and sometimes on section present a stratified appearance and possess a central cavity. These concretions are composed of organic matter derived from the prostatic secretion, and give the reaction of amyloid material. When old they may become calcified and invested in a deposit of phosphate and carbonate of lime, and then form prostatic so-called "calculi." They vary in number from a few to two or three hundred in one prostate, and some by passing into the urethra escape with the urine.

They rarely cause any *symptoms* unless their presence gives rise to inflammation of the gland. In a few instances, however, they have caused irritation at the neck of the bladder, hæmaturia, and obstruction to the flow of urine. When a sound is passed over the prostatic urethra a creaking sensation is felt.

The *treatment* consists in removing the calculi with urethral forceps, or, if this cannot be done, by a median perineal incision, care being taken to injure the gland as little as possible. This operation is resorted to only when the calculi are numerous or large.

Prurigo and Pruritus.

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Historical Note.—In the days of Willan, and long after, the word Prurigo was a collective term for different itching affections of the skin. In those primitive stages of pathological knowledge classification could only be made by reference to superficial and obvious features. Thus any disease with an eruption of papules, accompanied by an intolerable sense of itching, was regarded as lichen, or strophulus, or as one of the prurigos. With fine insight Willan recognised that pruritus was the "leading circumstance" in the pruriginous affections. These he arranged in groups which, in accordance with the fashion of the times, he called "species," taking for his distinguishing mark such obvious features as degree of severity, extent of the disease, and the period of life. His so-called species were P. mitis, P. formicans, P. senilis, P. localis, and he placed them all in the order of Papulæ. The views of Willan prevailed in England, France, and Germany until Hebra dismembered the order. Hebra admitted as prurigo what Willan named P. mitis and formicans, and he maintained that the other eruptions were simply the result of itching of the skin, or pruritus. In the Hebra period classification had begun to feel the influence of the new science of pathology. The internal forms of eruptions were being revealed for the first time. Thus in respect of the lesion of prurigo what to Willan had been merely a papule, became to Hebra an intra-epidermic cyst, which he regarded as a specific lesion, and the actual cause of the patient's suffering. His extraordinary experience of this disease, the regularity with which the symptoms grouped themselves in a striking clinical picture, convinced Hebra that this disease was to be regarded as an "entity," and to be entirely separated from the other pruritic affections. The force of Hebra's opinion carried the day at least in England and Germany. Prurigo became an independent substantive disease, and pruritus was defined as itching *sine materia*, and itching affections provoked by epizoa were named after the parasite which was present. This is the current opinion in Great Britain at the present time, though Mr. Hutchinson has strongly protested against it. It has the merit of being easy of comprehension and is free from mystery.

The third period, through which we are now passing, may be styled the philosophical, and is dominated by the French writers. To attempt to give even a sketch of the opinions and counter-opinions of Vidal, Tenneson, Tommasoli, Brocq, Besnier, Foulard, Jacquet, Neisser, and others, would demand many pages. But the volume of controversial literature is evidence that the old hard and fast lines of definition of the Hebra period are breaking down. Modern pathology is half a century in advance of the days of Rokitansky. Now we see the folly of impounding diseases within fixed circles of definition, and the tendency of the scientific nosologist to-day is to look past the superficial and obvious features of diseases for deeper and deeper resemblances having relation to their origin. From this results the modern arrangement of diseases into natural *series*. Thus the French writers, in endeavouring to establish a natural prurigo series, are quite in touch with the spirit of the times. The growth of our clinical knowledge, they say, has brought to light many cases of atypical varieties of prurigo Hebræ, and cases which have very little superficial resemblance to prurigo, but which present points of deeper resemblance. They maintain that the prurigo of Hebra is not an entity, but a symptom group which stands out in bold relief amid other groups less regular in form, and of lower degrees of constancy. Those who take this view regard the eruption on the skin in all varieties of prurigo and pruritus as merely reactions of the integument to traumatism, or to accidental microbic infection. This has been strongly insisted upon by Besnier and Brocq in France, by Hutchinson in England, and by Touton of Wiesbaden. On the other hand, Tommasoli regards the firm sero-papule, or as we should say, the cystic papule, as the essential lesion of prurigo. For this reason he excludes from the prurigo series the lichenified forms of Brocq. But whoever holds this opinion is logically bound to accept the inference, namely, that the cystic papule is antecedent to the pruritus, and, in short, the actual cause of the disease and of the patient's sufferings. Further, if the lesion is specific its formation should follow a definite routine, and the microscopists would, in the main, agree as to its form and character. This, however, is not the case. Scarcely two histologists agree in their results (see Anatomy of Prurigo, p. 104). The cystic papule of prurigo is frequently found in eczema. Again, cases of prurigo occur as shown by Neisser, in which prurigo begins with urticarial lesions and not with the sero-papule. Jacquet has proved experimentally that pruriginous lesions may completely disappear, simply by excluding them from all exterior influences, while at the same time the pruritus persists. In the light of this evidence we can only conclude with Besnier and Brocq that the eruptions on the skin in prurigo and allied disorders do not form an essential part of the disease, but are merely the reaction of the integument to traumatic influences. Our knowledge of these auto-traumatic lesions, or traumatides as I have ventured to call them (see p. 101), has been advanced by Brocq, who in 1891 lectured on the "theory of lichenification" (p. 102).

Beyond this point we enter on more debatable ground, whether we should follow Besnier's arrangement into four groups, each labelled *Prurigo diathésique*, and differing according to the objective mode of cutaneous reaction, or Brocq's four varieties of *Névrodermite*, is a matter for the future to decide. In the present article I have treated *Prurigo Hebræ* as a symptom group. I recognise the existence of other groups belonging to the same series. But the arrangement adopted is categorical rather than scientific.

General Characters of the Prurigo Series

Before any disease can be admitted into the prurigo series it is essential that it possess the following characters:—The affection of the skin must first be latent. Without giving any eruptive sign the skin of the individual falls into a certain state, of which the first symptom is a sensation of itching or pruritus, this being followed by moderate, or immoderate, bodily excitement (scratching), which provokes traumatic lesions in the skin.

Pruritus.—To the question, What is pruritus? the physiologists of to-day can give no certain answer. Indeed, what little information we possess is the result of introspection based on a few facts culled from common experience. In order to awaken this sensation we only need to touch the surface with the point of some delicate object, such as a hair or the barb of a feather. Physiologists have elicited the fact that this property is not equally distributed all over the surface. Thus, if the back of the hand be touched lightly with the point of a hair, scarcely any sensation of itching is provoked, but if the side of the nose be touched in like manner there instantly arises a strong sense of itching. And, what is very curious, this sensation persists for an appreciable interval of time after the irritating object has been withdrawn. The sensation is rapidly followed by a considerable amount of bodily excitement. The magnitude of this excitement is out of all proportion to the delicate and feeble stimulus which provoked it. The excitement runs to a crisis commonly called scratching. After this there is a sudden abatement of the sensation.

Thus the word pruritus connotes not merely a sensation, but a series of processes beginning in some latent changes in the surface of the skin and ending in scratching. These are not of necessity morbid processes. Itching is a property of the skin, and is to be regarded as one of the common sensations peculiar to the integument of all warm-blooded animals. As Prof. Bronson (1) points out in his admirable essay on the *Sensation of Itching*, pruritus is closely associated with the animal sense of contact. He affirms that the sensations originating in the surface of the skin, that is, in the epidermis, are of a low order. They fail to convey to the mind any definite perceptive ideas regarding the properties of the thing that touches the surface.

This is evidence that the sensation of itching starts in the undifferentiated nerves of the epidermis, and proceeds to the spinal cord without throwing into action the deeper specialised sense organs of the skin. No fact of common observation or in cutaneous pathology contravenes this conclusion, so we may take it for granted that *the seat of pruritus is the epidermis.*

Physiology has not yet given us a satisfactory reason for the muscular excitement which follows the pruritic stimulation of the free nerve ends. Bronson and Payne explain it by the vagueness of the stimulation and the involuntary desire to substitute "an effective energy for an ineffective vexation" (Bronson). It cannot be denied that the act of scratching is *apparently* directed to a certain end, and so far we can say that a vague conception is usually associated with pruritus. But when a man who is asleep, or even comatosed, tears at his skin, it is obvious that neither conceptions and desires, nor any other psychological act, have anything to do with his pruritus.

To pursue this question further would only lead on into metaphysics. It is wiser to wait until physiology furnishes us with some definite facts.

The Causation of the Pruritic State

It cannot be insisted on too much that pruritus is the symptom and not the disease. The real disease underlying all the prurigos is latent. Of itself it produces no lesion; it rouses no cellular reaction, and no inflammation. Our ignorance of it is profound, therefore we write of it in terms of wide generality and often of vague and inexact meaning. It begins insidiously, and grows with the individual; often it is the only symptom, and the patients make no complaint of ill-health. The bodily functions so far as we can detect may be in no way disturbed. It sometimes occurs along with other symptoms, forming what we may call indefinite cases. Again, it may be associated with pronounced diseases of certain organs, for example, obstructive jaundice. It may assert itself in gout, in uræmia, and in Graves' disease. I have known it to be the most distressing symptom in general lymphadenoma. No period of life is exempt from it. In that particular manifestation of the pruritic state which we call prurigo Hebræ it begins in infancy or early childhood. It certainly assumes new aspects at different ages. The form of an adult prurigo is generally different from that of the child, while often in old age the pruritic state is lesionless. Some varieties are met with only among the very poor, but the well fed are not exempt. Of temperaments it may be said that the neurotic are prone to it, but some bad forms are associated with what we call the strumous, and the French the lymphatic temperament. But out of all this uncertainty we can at least fix this general truth, namely, that a *pruritic state* springs from antecedents which do not follow any routine track. Like fever, it is a perturbation of wide generality from which no warm-blooded animal is exempt.

According to Besnier (2) the main pathological condition of the prurigos lies in the adulteration of the blood, or of the lymph, or of the intercellular fluids. This adulteration he believes to be autonomous. That the stimulus which provokes the sensation of itching is chemical in its nature receives the support of the eminent physiologist Prof. Kiesow.[1]

The Consequences of the Pruritic State; Traumatides.—For convenience of description we may divide these into (1) Cutaneous, and (2) General, or those which relate to the health of the individual.

1. Cutaneous.—To save repetition, and for brevity sake, I propose to speak collectively of these scratch lesions of the skin as *traumatides.*

It is the merit of the modern French school of dermatologists that they have insisted on the fact that the essential disease of the prurigos is *latent.* By this is meant that the skin of an individual may gradually fall into certain pathological states of nutrition, and at the same time give no objective sign of it until provoked to do so by scratching. Then a variety of lesions arise. According to Besnier and Brocq the form of the lesion is not controlled by the scratching, but by the individual himself. Traumatides are in themselves banal, and possess no fixed anatomical character. Their importance is derived from the fact that *they indicate the state of nutrition of the skin at the time of the traumatism.* The following traumatides have been observed:—

(1) Wheals.—Urticarial lesion may be regarded as traumatides. They occur most readily in infants and children, and indicate a state of tension in the vaso-muscles (probably veins) which when stimulated contract spasmodically.

(2) *Scaly spots;* these are due to the loosening of the horny epidermis.

(3) *Excoriated red spots* are formed by tearing fragments of the hard epidermis from the underlying soft epidermis.

(4) Vesico-papules or cystic papules.—These are common in childhood, adolescence, and in adults, but not so frequent in the aged. They are due to the forming of cystic cavities, with fluid contents, in the epithelium.

(5) *Broad hemispherical small nodules,* pale at first, but later becoming

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[1] This opinion was conveyed in a letter from Prof. Kiesow to the writer.

red. These are characteristic of prurigo Hebræ. They are due to the formation of cystic cavities, but situated deeper beneath the horny layer.

(6) Torn papules bearing at their summits a minute blood scab.—These are the commonest of all traumatides, and are met with in persons of all ages. They are a variety of the cystic papule.

(7) Pustules, superficial abscesses, and boils. — These are the consequence of microbic infection. They are most readily formed in persons of strumous temperament. Individuals of this class are distinguished by thick, coarse skin, with large sebaceous follicles. The lips are usually thick ("lymphatic") and the eyelids thickened.

(8) "Lichenification."[1]—Brocq (3) was the first to give us in 1891 an exact description of this form of traumatide. "When," says this authority, "a person who is predisposed, and the predisposition is indispensable, repeatedly scratches some circumscribed patch of skin which is the seat of pruritus, it may determine more or less quickly certain morbid changes. The skin thickens, becomes hard and rugose, the papillæ hypertrophy and groups of hypertrophied papillæ produce papules of irregular and unequal size. The normal folds and surface markings may be exaggerated, forming a sort of quadrilateral mesh. The integument is more or less infiltrated, and has lost its suppleness and normal consistence." To this alteration of skin Brocq gave the name "lichenification." When this lichenification arises in a skin apparently healthy it is termed primary lichenification. Far more frequently it is secondary to some previous eruption, such as eczema or lichen planus.

The rapidity with which, in some cases, large islands of pigmented and indurated, or "lichenified," tissue may arise in a circumscribed area, which is the seat of pruritus, without any previous signs of abnormality, is one of the strongest proofs that the nutritional state of the skin may deviate considerably from the normal without giving any spontaneous eruptive symptom. This form of traumatide is met with in neurotic persons, and may be associated with jaundice. It sometimes follows mental shock or states of mental worry and depression.

(9) Eczematisation.—Besnier has applied this term to patches of superficial inflammation presenting all the polymorphic characters of eczema, namely, hyperæmia, vesication, oozing, desquamation, and suppuration.

(10) Pigmentation.

(11) General dryness of the surface.

General Consequences of the Pruritic State

If we are to judge of the importance of a pathological condition by the greatness of the consequences which proceed from it, there are few more important than those of which pruritus is the symptom. If the itching is severe the sense of torment replaces every other consideration. To work is impossible, and to sleep no less so. The power of concentration is weakened, and with loss of control there is developed an irritable temper. The unfortunate person falls into a "nervous condition." The approach of night brings no promise of relief, for sleep which subdues pain has no power to arrest pruritus. The disturbance in the peripheral nerves and the spinal excitement still goes on. Too often the patient is sleepless, and makes frantic efforts to relieve his torment by tearing at the skin. Should this continue without intermission it would speedily end in madness, but the irritation is intermittent and paroxysmal, and in the calm intervals he recovers to some extent. If the pruritus is acute and temporary, or even if it is chronic, provided it is not of a severe character, the general state of nutrition may even be good (Hebra). But in many cases the entire nutrition of the body suffers, and this is generally observed in neurotic adults. The misery of these unfortunate persons is increased by their social ostracism. Pain wins sympathy, but pruritus only aversion and annoyance. In childhood he is scolded by his teachers and jeered at by his schoolfellows, and later in life he comes to be avoided as an object of contagion, since the act of scratching is always suggestive of parasites. Thus the whole life of the sufferer is dominated by his complaint, his lot is isolation, and we need not wonder if it drifts into melancholia, or terminates in suicide.

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[1] Besnier prefers the term lichenisation. Primary lichenification of Brocq-Jacquet corresponds to Vidal's lichen simplex chronicus circumscriptus, a term which, even in France, will soon be obsolete.

Clinical Groups in the Prurigo Series

In sketching the general character of the prurigo series it was pointed out that the essential disease underlying all forms of prurigo and pruritus is some latent change in the nutrition of the skin, which is accompanied by an intermittent and paroxysmal sensation of itching, and later by the appearance of traumatides or scratch lesions. The present imperfect state of our knowledge of the pathology of the pruritic states forbids us even to attempt a scientific classification of these disorders. All we can do is to arrange our cases into groups, according to circumstances which seem to us more or less striking. The result of the arrangement is merely a catalogue of cases, and is not to be regarded as a natural classification.

Prurigo Hebræ.—*Pruritus in badly nourished Children, followed by pronounced malnutrition of the Skin and severe traumatides, continuing more or less through Life.*—According to Hebra the disease begins in infancy and continues throughout life. The earliest objective symptom is that of subepidermic papules, which form in all parts of the body surface, except in the skin covering the bends of the joints. The face, throat, and neck are rarely affected to any extent. The papules are isolated, and increase in number in the lower limbs. In long-continued cases the whole nutrition of the skin suffers. It becomes harsh and rough to the touch, of thicker consistence and of darker complexion than in health. The itching is more or less constant, but subject to exacerbation and paroxysm, especially at night. Hebra firmly maintained that the subepidermic papule was the essential part of the disease, and that it was the inevitable antecedent of the itching. This by many is considered doubtful, and the evidence points rather to the lesion being secondary to the scratching. In consequence of scratching the skin over the papules becomes reddened and excoriated, and the papules discharge a fluid which dries into a scab. If the lesions below the knee are numerous the inguinal glands inflame and become enlarged, forming the so-called prurigo bubo. When the disease is fully established the general aspect of the patient is highly characteristic. When he is stripped for examination we notice that there is a clustering of the lesions chiefly below the hips, the maximum development being reached below the knees. As the disease ascends it becomes feebler, and the lesions more widely scattered, till they cease on the neck and face. The general type of nutrition is commonly strumous or "lymphatic." The lesion most in evidence is the torn, scabbed, broad, hemispherical papule, often intermixed with ecthymatous pustules; in some cases with patches of infiltrated eczema.

Etiology.—The causation of prurigo is unknown. We know of no irritant which can produce it. It commonly appears during infancy, but, according to Neisser and Ehlers (4), it may originate later in life. According to the latter of these authorities the date of onset varies from a few days to twenty-nine years of age, the average of 207 cases being five and a half years. Hebra maintained that prurigo was never congenital; Ehlers, however, believes heredity plays an important part in its causation. "It occurs," says Hebra (5), "almost exclusively in poor subjects and those ill-nourished in childhood, and so most often in foundlings and beggars' children. Those who have enjoyed a good physical education in early youth, and have always been properly fed according to their age, suffer very rarely indeed from prurigo." The prurigo of Hebra has curious geographical relations. In point of frequency Vienna seems to be the headquarters of the disease, and this city is the centre of a mixed population of Austrians, Germans, Tyrolese, Slavonians, Hungarians, Jews, Italians, etc. It has been noticed that the offspring of sufferers emigrating from Vienna to a country where the conditions of life are easier and more wholesome, do but rarely manifest the particular group of symptoms which have been described above. Professor James C. White (6), of Boston (U.S.A.), has made a careful study of the non-prevalent distribution of "prurigo" in the United States. It appears that prurigo is an almost unknown disease among the American people as a whole, and it is only rarely observed in immigrants from European countries, and in their descendants.

Anatomy.—Hebra and Simon regarded the elementary lesion of prurigo as a species of vesicle. Kaposi regards it as analogous to the papule of eczema. According to Riehl they are similar to the papules of urticaria. Vidal considered them to be analogous to the papules of lichen. Wedl and Neumann believe that they are the product of exudation into the cutis. Auspitz and Caspary consider that they are the result of proliferation of the rete Malpighii. Leloir found the prurigo nodule to be associated with a cavity formation in the prickle layer. According to this authority the cysts are formed by the destruction of prickle cells and not by exudation. The cysts enlarge, but never invade the horny layer. Kromayer found minute cysts in the horny layer, and accompanied by hypertrophy of the epidermis, with some cell infiltration in the upper part of the cutis. Epidermic cysts have also been noted by Campana and Bonfigli. Prurigo papules a few hours old have been examined by Darier. He found the lesions to consist of an area of colloid degeneration in the epidermis surrounded by signs of acute inflammation, namely, œdema, vesication, and leucocytosis. According to Du Mesnil the primary anatomical change is the thickening of the epidermis, which leads to the retention of sweat in the sudoriparous ducts, and so to the formation of cysts. These varied and contradictory opinions are of themselves quite sufficient proof that the lesions of prurigo are banal, and have no definite anatomical character.

Diagnosis.—Prurigo Hebræ being a rounded and complete symptom group, diagnosis depends on our acquiring a general impression of the disease rather than upon the detection of minute details. The diseases with which it may be confounded are those in which itching is a leading feature. In every supposed case an examination for parasites should be made, for the presence of epizoa alters both the prognosis and the treatment. The distinction between pruritus and prurigo, in the broadest sense of the term, is perhaps more academic than scientific. The essential basis of every case of prurigo is pruritus, that is, a tormenting sense of itching. For convenience' sake we separate the terms, and employ the name "prurigo" where the subjective and objective symptoms are grouped in a certain way.

Scabies is distinguished from prurigo by the detection of burrows, or the acari, and also by the history and nature and grouping of the lesions. *Chronic eczema* is not accompanied by the degeneration in the nutrition of the integument, nor by the scattered, torn hemispherical papules which are characteristic of prurigo. In chronic *pediculosis* the lesions are chiefly on the back between the shoulders, and the pigmentation of the skin is usually marked. The examination of the clothes will generally decide the question.

Prognosis.—1. Hebra regarded the disease as hopelessly inevitable. Ehlers found improvement after puberty. It seems certain that unless the circumstances of the patient can be greatly improved no hope can be looked for. The disease, however, is subject to remission. During the summer months Hebra noted a considerable amelioration of the symptoms, the disease being always worse in winter.

2. *Pruritus followed by urticarial traumatides occurring at all periods of life, but more frequently in infants and children.*—This will be discussed under the head of Urticaria, but I believe that the proper nosological place of this class of disorder is in the prurigo series.

3. *Pruritus beginning in adult life and followed by traumatides of the nature of torn papules showing no tendency to aggregate by fusion, and scattered discretely, especially over the extensor surface of the limbs.* (*Prurigo simplex*, Brocq. *P. temporaria*, Tommasoli.)

(1) *Acute Form.*—According to Brocq (10) the onset is rather sudden, but without constitutional disturbance. The eruption takes the form of firm, solid, red papules, often torn at the summits and tipped with a minute scab. The skin is in the urticarial condition, and wheals may be present. The papules, which are always discrete and never fused into patches, are distributed chiefly over the extensor surfaces of the limbs, especially the forearms, elbows, knees, and dorsal surfaces of hands and fingers. The flexor surfaces of the limbs and the bends of the big joints are free, or only very slightly affected. The disease runs a course of from two to eight weeks, and ends in recovery. Relapses are frequent. Lichenification and eczematisation are not met with in this variety. According to Darier, the papules of P. simplex have the same anatomical character as the papules of prurigo of Hebra. This variety is practically identical with lichen urticatus of children.

(2) *Chronic Form.*—Objectively indistinguishable from the acute form, but continuing for months or years. Both these varieties are apt to occur in highly neurotic persons.

4. *Pruritus followed by traumatides secondary to mental shock.*—Many cases are now recorded in which a sudden mental shock or great grief has been followed by pruritus. The traumatides are not always of the same character. In some cases the lesions take a distinctly lichen planus form. In some of these cases the pruritus may be local instead of general.

5. *Pruritus with traumatides recurring in successive winters* (*P. hiemalis,* Duhring).—This class of case, described by Prof. Duhring of Philadelphia under the name of *Pruritus hiemalis,* is characterised by the fact that the pruritus occurs only in the cold weather. As a rule it appears between October and January, and disappears in April or May. The whole body may be affected, but generally it is worse on the extensor surfaces of the limbs, especially on the thighs. The itching is worse on going to bed and on rising in the morning, and less troublesome in the middle of the day. The traumatides are not pronounced in character, but

the skin may become rough, excoriated, and marked by scattered, torn papules. Persons who suffer from this form of pruritus have sometimes remarkably dry skins. According to Corlett (11), the state of the general health has no appreciable effect on the pruritus. Local irritation of clothes may aggravate, but does not produce it. He believes that the meteorological conditions most apt to provoke the pruritus are a low temperature, low humidity, with N.W. winds. The greater the velocity of wind the greater the pruritus.

6. *Pruritus followed by traumatides recurring in successive summers.*—These cases are rarer, but individuals exist who are more sensitive to heat than to cold, and whose pruritus disappears in the winter to reappear in the summer.

7. *Pruritus following pregnancy and menstruation* may be local or general. In certain women it occurs with each pregnancy and subsides after delivery. There is nothing to distinguish it from other forms of pruritus except its association with the physiological events of pregnancy and menstruation.

8. *Pruritus with pronounced and multiform traumatides concurrent with jaundice, uræmia, diabetes, or intestinal bacterial toxæmia.*—According to Besnier, the immediate irritant is not the bile pigments, urea, or sugar, but some irritant liberated by these agents. There is some condition of which we are ignorant, for there are many cases of jaundice, uræmia, and diabetes in which no itching occurs. Objectively this group is characterised by traumatides of the nature of lichenification and eczematisation.

9. *Pruritus without traumatides in the aged* (*P. senilis*).—These cases are characterised by the fact that scratching does not produce traumatides, or at most only a few slight lesions. It is supposed to be due to atrophic degeneration of the skin. In some cases it is associated with lithæmia, obstructive jaundice, chronic Bright's disease, and diabetes mellitus. When pruritus becomes established in old people it is incurable.

10. *Pruritus affecting restricted areas* (*P. localis*).—It is a good rule to assume that all local forms of pruritus are due to local causes until *proved* not to be so.

(i.) *P. vulvæ in children* is often reflected from the rectum, due to the irritation of ascarides.

(ii.) *P. vulvæ in adults* may be provoked by saccharine urine, or acrid vaginal discharges. It may be a premonitory symptom of carcinoma uteri (Kaposi). In many cases we entirely fail to discover any cause. Some persons have a nervous history. One of my patients presented the following family history: two brothers were insane, the father was "peculiar," and had been afflicted with sexual incompetency; the paternal grandfather was at one time insane; the mother, now living, is highly neurotic, and would be described in society as an "oddity." The itching affects the labiæ and the clitoris, and often the lower part of the vagina. Prolonged scratching is apt to lead to great induration of the parts, and to the formation of papules. But in other cases traumatides may be absent, or the labiæ may be slightly hyperæmic and excoriated. Pruritus in this region is apt to produce depression of spirits. According to Bronson it may be associated with voluptuous sensations.

Pruritus ani.—The pathological conditions which give rise to this troublesome affection are commonly to be found within the sphincter or in the lower third of the rectum. If the anus is dilated minute fissures may often be seen lying between the folds of skin. Slowness of circulation, especially if combined with varix or hæmorrhoids, is a frequent cause of pruritus. In certain cases some article of diet, such as coffee, occasions the itching. Itching in this situation is intolerable, and scratching leads to eczema, with formation of fissures. Gouty and neurotic persons are more prone to it than others. In women it may appear at the menopause. It must not be forgotten that anal pruritus, like that of the vulva, may be a symptom of pathological changes in the uterus, such as fibroma or carcinoma, or of carcinoma of the rectum.

Pruritus palmæ et plantæ is very rare. Gouty persons are more prone to it than others.

Pruritus linguæ has been recorded in one or two instances.

TREATMENT

I. MANAGEMENT OF THE INDIVIDUAL.—(1) *General measures referable to all cases of pruritus, whether associated with prurigo lesions or not.*—*Food* must be of good quality, and suitable to the age of the patient. The relative proportions of fats, carbohydrates, and proteids have not yet been determined, but every case must be studied on its own merits. Ivanow recommends the introduction of a large quantity of fatty food into the dietary of prurigo children. A meal rich in proteids is apt to aggravate the sensation of pruritus. All forms of alcohol are calculated to increase cutaneous irritation, especially champagne and liqueurs, but some cases in which nutrition is subnormal and feeble, whisky and water or dry wines may be advisable. Brown-Sequard draws attention to the action of coffee provoking or aggravating pruritus. If atony or dilatation of the stomach exists, the meals should be light and should be taken at shorter intervals.

Air.—This should be abundant, and as pure as possible. If the humidity is too low the air may cause irritation. Wind, to some individuals, is a direct cause of pruritus.

Light increases metabolism, and so far may affect the pruritus. Its physiological action must also be borne in mind. *Fermentation* and *catarrh* in any part of the alimentary canal must be corrected. If *muscular atony* and dilatation of the stomach exists, massage and graduated exercises will prove beneficial.

(2) *Special measures to be selected according to the nature of the case.*—In adults suffering from pruritus or prurigo, *rest* is the great desideratum. By this is not meant idleness. It is highly desirable to enliven the patient's interest in things around him, What is needed is a true adjustment of the individual to his work, that this be so ordered that every part of it becomes effective. Nothing is more calculated to produce depression and to wear a man down than ill-directed work ending in failure. Harmonious work is a great therapeutic agent. Many a patient may be saved from misery, if not from insanity, by giving him a better method of work. And this principle applies to the holiday times no less than to the hours of business.

Climates for pruritus.—This is one of the most valuable of measures for restoring the pruritic patient, especially if associated with exhaustion from overwork, or with functional disturbance of the nervous system. But whether we send him far or near, to sea or country, to hill or valley, must be determined by a variety of circumstances which call for wise discrimination. Brightness and pure air are good, but there must be sympathy between the individual and his surroundings. To send on a long voyage a hypochondrical person who hates the sea is to invite him to commit suicide. If such an individual were something of an antiquarian, he would have a better chance in the British Museum studying coins or mummies. If there is much exhaustion, or feebleness of constitution, a long journey is to be avoided, nor should the climate be too vigorous. High altitudes are not favourable to hysterical natures, but are highly beneficial to the lymphatic and sanguine. On the whole, a warm, equable climate is the best—one in which the indoor temperature corresponds with that out of doors. Countries of sharp thermal contrasts, as between hot interiors and freezing exteriors, and between mid-days and evenings, are to be avoided by the pruritic. This is probably one of the reasons why pruritus is so prevalent in the north-western States of America, where the people are exposed to great disparity of temperature.

Insomnia is one of the great difficulties with the pruritic. Brain sedatives, Dr. Payne (12) thinks, are advisable. He recommends chloral in full doses, and antipyrin. Bulkley speaks well of gelsemium and cannabis indica. A complete hot bath, especially if bran or starch be added to it, and taken at bedtime, sometimes affords great relief. Brocq strongly advocates the daily hot douche. Electrical treatment has proved serviceable in some cases. The well-to-do may avail themselves of the electric bath, or large sponge electrodes connected with an induction coil may be moved over the surface of the trunk and limbs.

II. The Management of the Skin.—When in the course of pruritus the nutrition of the skin becomes affected, measures are required to restore it to a healthier state. The hot bran bath followed by inunction can do much towards this. Harsh dry skins should always be anointed with oil or salves morning and evening. The addition of tar to the ointment has a sedative effect. Kaposi recommends beta naphthol, and more recently epicarin, one of the naphthalin compounds. If there is much infiltration and thickening of the skin Hebra's soap treatment should be tried. This consists in washing the skin with a flannel and the spirit solution of soft soap, afterwards applying some soothing ointment. If the pruritus is confined to a limb, the occlusion method recommended by Jacquet and Tenneson may be tried. Jacquet's plan is to fold cotton wool round the limb, and apply over it a bandage in such a way as to exclude air and traumatism. The results are described as astonishing; all the lesions disappear, and in some cases, but not all, the pruritus also. Tenneson advises the use of guttapercha tissue or india-rubber dressings. Colombini speaks favourably of menthol dissolved in spirit. Cocain (20 per cent) applied locally in the form of ointment or lotion gives temporary relief, but does nothing towards a cure. Hatschek reports favourably of massage. Pilocarpine injections are recommended by R. M. Simon. Good results are said to have been obtained by the continuous electric current when the pruritus is confined to a limited area. But, after all, none of these measures touch the root of the disease. The only rational treatment is that which is based on a study of the individual himself.

Treatment of local pruritus.—Only two varieties need be discussed under this heading, namely, P. vulvæ and P. ani.

P. vulvæ.—All local sources of irritation must be searched for and removed as far as possible, such as vaginal discharges, fissures, saccharine urine, ascarides, hæmorrhoids, and morbid conditions of the uterus. Care must be taken not to overlook the presence of parasites. If eczema be present this must be cured (*v.* art. "Eczema). If the labiæ are thickened carbolic or tar ointment may be applied. In some cases the cautious application to small areas of 95 per cent carbolic acid gives relief, or even removes the pruritus. In obstinate cases burning the parts thoroughly with the thermo-cautery is effective, and may result in a complete cure. For this operation generel anæsthesia is necessary, and the patient will require to remain in bed for three or four weeks.

P. ani.—The treatment of this is similar to that of P. vulvæ. We must remember that it more often depends on defective circulation, and that gouty remedies may be necessary. The patient's diet may require regulating. The abuse of coffee should be stopped. As regards local treatment, Ohmann-Dumesnil recommends the application of pure creasote. Phenol may be used as for P. vulvæ, but neither this nor the creasote should be applied on consecutive days. If the anus be kept firm and dry it will add much to the comfort of the patient. This may be attained by sponging the parts with a 0·5 per cent solution of silver nitrate or acetate of lead in spirit, water, or nitrous ether, and after this dusting *into* the anal passage a drying antiseptic powder.

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Prussic Acid Poisoning. *See* TOXICOLOGY.

Pseudo-Cyesis, OR SPURIOUS PREGNANCY.

This comparatively rare condition is a variety of a group of cases recognised under the heading of "Phantom Tumours." It occurs chiefly amongst those who have recently been married, or who are approaching or have reached the menopause, or in cases where illicit intercourse has occurred followed by fear of pregnancy. Again, in some cases no reason can be assigned for the occurrence of this phenomenon, while in others it may arise as a result of an eczematous patch in the neighbourhood of the umbilicus, as in a case described by Sir William Bennett (1), or as a result of pelvic peritonitis, which produced partial obstruction of the sigmoid owing to the formation of adhesions (2). Opinions differ as to method of formation of such tumours. Some distinguished authorities, amongst whom may be mentioned Addison, Gull, Paget, Spencer Wells, Bennett, believe that they arise by contraction of the abdominal muscles. While others, following the researches of M'Ardle and Kolipinski (3), hold that they are generated by an atonic condition of the intestines, which results in the accumulation of gas and consequently distension. Sir James Y. Simpson was of opinion that spasm of the diaphragm was the cause (4). It is worthy of note that such tumours are not confined to the human species, they also occur in the bitch and ass. Two types may be described amongst women who suffer from this condition: in one there is abdominal enlargement, and no other symptoms present except those of imaginary fœtal movements due to flatulence, in the other there is also abdominal enlargement, and in addition many of the symptoms and some of the signs of an ordinary pregnancy. Amenorrhœa, morning sickness, mammary changes, may be present in the latter type.

The diagnosis of the condition is easy provided that one is not deceived by the statements of the patient, and that a physical examination is made. Suspicion as to the true state of affairs may be aroused by the mental attitude and age of the patient as well as by incongruity in her statements; signs and symptoms not developing in correct order, or being absent when they should be present. On examination it may be found that increase in the size of the breasts and abdomen is due to the deposition of fat. In nulliparæ no mammary secretion can be expressed. Even in cases where the abdomen is the size of a full time pregnancy the umbilicus remains depressed, and no fresh purple striæ gravidarum are present.

On percussion over the tumour the note may be dull, but not so absolutely dull as over a pregnant uterus. Auscultation will give negative results, and though the intestines are distended with gas borborygmi in most cases are not audible. On vaginal examination the usual signs of pregnancy are absent. Diagnosis may be confirmed by placing the patient under the influence of an anæsthetic. When complete anæsthesia has been reached the tumour gradually disappears. Bennett recommends that the hand should be gently placed on the tumour from the time when administration of the anæsthetic is begun. During the earlier stages it will be found to increase a little in size and hardness. With the onset of complete anæsthesia a little quivering motion will be felt, and then the tumour will gradually melt away under the hand. They never disappear suddenly.

Prognosis.—In many cases, specially amongst recently married women, the tumour and all symptoms of pregnancy disappear when the true state of affairs has been revealed. In others, again, the condition ends only when a spurious labour has convinced the patient of the truth of the obstetrician's diagnosis. While in some, and more especially in nulliparous women who have reached the menopause, it may be impossible to dispel the delusion from which they suffer; the symptoms may last for years, and spurious labour recur at intervals.

Treatment of the condition in most cases lies entirely in convincing the patient that she is suffering from a delusion. The exercise of much tact may be called for. At the same time an endeavour should be made to ascertain the existence of an underlying cause, such as pathological pelvic conditions, and if discovered this should be attended to. Adiposity, dyspepsia, and flatulent distension should receive appropriate treatment.

LITERATURE.—1. BENNETT. *Lancet*, Jan. 4, 1902.—2. HIRST. *Text-Book of Obstetrics*, 1900.—3. M'ARDLE and KOLIPINSKI. *New York Med. Journ.* vol. xliii.—4. *Clinical Lectures on Diseases of Women*, vol. iii.

Pseudo - Hypertrophic Paralysis. *See* MUSCLES, PARALYSIS.

Psilosis. *See* SPINE.

Psoas Abscess. *See* SPINE.

Psoriasis.

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SYNONYMS: *Lepra* (Willan), *Alphos* (E. Wilson) are both obsolete. Fr. *Psoriasis*; Ger. *Psoriasis, Schuppenflecle.*

DEFINITION.—A chronic and recurrent disease, characterised by dry, red inflammatory discs almost concealed by a crust of adherent silvery scales.

CLINICAL FEATURES.—Psoriasis is one of the most common diseases of the skin in Northern Europe, where it constitutes from seven to eight per cent of all skin diseases; while in Southern Europe and America it only occurs in from two to three per cent. In private practice it is the second most common disease.

Most of the varieties created by older writers were artificial, and little more than convenient labels for different stages in the evolution and involution of the disease, their chief justification being that the eruption may stop at any of the stages for a considerable time, and even disappear without traversing the complete gamut of development and involution.

Psoriasis commences as a papule the size of a pin's head, slightly reddened and scaly from the first, though sometimes a slight scratch with the nail is required to demonstrate the scaly cap. This stage is P. punctata. It soon flattens and enlarges peripherally to a scaly spot (P. guttata), and this again to a disc which may develop to or stop short at any size from a threepenny to a crown piece (P. nummulata). Isolated patches are seldom larger than this, but by coalescence with other patches an extensive area may be covered (P. diffusa), the borders of which are gyrately outlined. In the retrogressive stage, involution commences in the centre, by a diminution in redness and scaliness going on to complete clearing away, leaving a circle with raised scaly border and normal or slightly pigmented centre in an isolated disc, or an irregular gyrately-outlined area with the border one-eighth to one-quarter inch wide in a compound patch. In a few cases these circinate and gyrate patterns are formed primarily from the eruptive elements having formed at and followed the distribution of the hair follicles, which constitutes what Willan called Lepra, a term now restricted to leprosy.

Reverting to the nummulate stage, which may be considered as the most typical condition, it may be observed that the lesion is a disc slightly elevated above and sharply defined from the surrounding healthy skin. All but the extreme edge, and sometimes even that, is covered with a white crust of adherent scales, their silvery hue being due to inclusion of minute air-bubbles in their substance. This crust is not easily attachable until involution sets in, but if removed forcibly the exposed base is seen to be of a red colour, with still brighter red points upon it which bleed readily, and are really the tops of exposed and enlarged papillæ of the cutis. The thickness of the crust varies greatly, and in extreme instances the scales are heaped up into a conical crust like rupia, hence the term P. rupioides. In almost all cases the crust is entirely composed of scales, but occasionally there is slight pustular exudation mixed with them, hence P. empyodes.

Itching is not a marked feature as a rule, but in gouty and alcoholic patients, and whenever there is marked hyperæmia, the irritation may be very pronounced, and the consequent scratching produces thickening of the patches, blood crusts, and excoriations.

The distribution of the eruption is an important feature in the general picture of the disease. Symmetrical in the main, there is a selective affinity for the extensor aspects of the limbs, especially about the elbows and knees, where the patches are apt to aggregate and coalesce even when scattered discretely in various sized discs over other parts of the body surface. No part of the body is absolutely exempt from the eruption, but the palms, and soles, and lower part of the face usually escape altogether, or are but slightly involved; but sometimes they are the first and the worst part affected. As a rule, next in order to the limbs, the scalp and the back of the trunk are most frequently and extensively involved. When every region of the body is extensively invaded P. universalis is present, but there are always some areas of healthy skin.

In a well-marked, fully-developed case, in a general survey, the eruption may be seen in all stages of development at once, affecting a large portion of the body surface; but however long the eruption has been out, and the patches have grown and coalesced, there are always some areas left clear of eruption. In most cases, however, there are in the first attack very few patches, and these may be confined to one or two regions, such as the knees, elbows, or scalp for a very long time, and then either gradually or rapidly extend. On the other hand, in some patients who have had previous attacks there may be an abundant outbreak from the first, the eruption comes out in crops at short intervals, and speedily involves every region of the body. Between the extremes there are all gradations.

Most cases run a very slow course, and whilst some, especially young subjects, may lose their eruption spontaneously for a time, in others there are remissions only, the disease lasting, unless vigorously treated, for many years.

Whether the eruption is removed by time or by treatment, recurrence is the rule, to which there are but few exceptions. And whilst in some patients the interval of freedom is only a matter of weeks or months, a few go for years without a fresh attack. The eruption leaves behind it a redness or slight staining at the site of eruption, but in some, especially when treated with arsenic, the pigmentation is marked and persistent. The converse, however, may occur; transitory achromia is often left after treatment by chrysarobin, but in rare cases it occurs persistently without apparent cause, and even scarring may be produced with slightly increased pigmentation round the patch.

Even when the eruption is very extensive the general health is unaffected by the skin lesions, but their condition is often influenced by the general health of the patient, deterioration in which may determine an outbreak or aggravate an attack.

Acutely inflammatory cases present a totally different picture from the subacute, more typical form previously described. While the extensor aspect of the limbs is still the most frequent position for it to start from, it is much more indiscriminate in its origin and distribution (in one case under the author it always began on the palms and soles), large areas are speedily involved, and the borders are much less defined than in the familiar discs; the ground colour is an intensely bright red, and the scales are not in glistening adherent crusts, but in flaky scales which shell off readily and frequently in large quantities, the general aspect approaching that of pityriasis rubra, into which it sometimes merges and then runs the course of that disease.

Limited areas with these characters may be seen sometimes in elderly persons, and even have a somewhat eczematous character though the patch is generally dry, and the condition Devergie called P. eczemateux is produced.

On the palms and soles, it is seldom seen without being present extensively elsewhere. It usually shows itself by thickening of the horny layer in small patches, and when this splits off it leaves whitish spots with a worm-eaten appearance. It is sometimes seen in scaly patches which may be heaped up considerably, but has not the lamellar aspect of the disease in other parts. In a few instances the disease has been limited to the hands, including the palms, for many years. The term palmar psoriasis is sometimes misapplied to dry palmar eczema, and a secondary scaly syphilide of the palm.

Sweat-duct psoriasis is generally unrecognised. The lesions are only one-eighth of an inch in diameter, but may cover a great part of the trunk or limbs. Although acuminate papules at first they soon flatten out into slightly scaly spots.

Follicular Psoriasis.—In this the primary papule is at the hair follicle and remains attached to it. The papules may be only millet-seed to hemp-seed sized, with a scaly top, or rather larger and not so convex. The eruption enlarges at the margin very little, if at all, so that the original character is preserved. The hair growth is unaffected in most cases of the usual type, although the eruption may be very thick upon the scalp; but in the acutely inflammatory cases, the hair is shed profusely even to complete denudation of the affected area.

The nails are frequently affected both in acute and chronic cases. The most common and characteristic change begins on one side at the distal end, where it is of a dirty yellow colour, thickened and separated from its attachments; this may extend all the way down, or the whole nail may be discoloured, pitted, furrowed, transversely thickened, and raised up from its bed by proliferated horny scales. The nail changes may commence at the root, distal end, or other part of the nail blade. The mucous membranes are almost exempt in psoriasis, though a few cases are on record affecting the palpebral conjunctivæ and the mouth. The so-called psoriasis linguæ is a misnomer, and although leucopathia linguæ is occasionally seen in psoriatic subjects the conjunction is accidental. Among the rarer complications are scarring, keloid, papillary development, either soft or warty, and from this even epithelioma may result. Sometimes the warty and epitheliomatous growths ensue, not directly from the psoriasis but as the result of excessive arsenical treatment.

Etiology.—Sex has probably no influence in predisposing to the eruptions. Statistics vary in their results in different countries. In the author's hospital cases the females were as two to one, and in private males and females were equal.

Age.—In the author's statistics of over 800 cases, 72 per cent begin before thirty years; the numbers before twelve, between twelve and twenty, and between twenty and thirty, being equal. Twenty-two per cent begin between thirty and fifty, in equal numbers in the two decades, and only 5 per cent over that age; below five years probably not 1 per cent, and it is very rare under two years, but there are a few recorded in the first year of life, the youngest being thirty-eight days, and this was said to have commenced in the first week of life (Rille). At the other extreme stands Watson's case with the first attack at eighty-five.

Heredity.—This is generally considered to play an important part in the production of psoriasis, though Bulkley and Rosenthal said that it could only be proved in 15 per cent of their cases, but it was probably in a much higher percentage. Nielssen disputes heredity altogether, and ascribes it all to family contagion; but there are only a few isolated cases in which inoculation seemed probable, including a few cases of vaccination psoriasis and one of experimental inoculation (Destot); Ducrey's extensive series of experiments failed, and there is a general concurrence of opinion that there is very little evidence to support a theory of contagion in this disease. The practical facts remain, that if one or both parents suffer from psoriasis one of a family of several children will be nearly sure to get it; but it is seldom that several in the same family have it, a fact rather against the idea of contagion.

Excessive meat eating is said to be a cause of this disease, and vegetarianism recommended as a preventative; but the author had as a patient a girl of thirteen with well-marked psoriasis, who was born with a dislike to meat and had scarcely touched it all her life.

Possibly after thirty, excessive meat eating may be conducive to gouty symptoms, and thus to some extent be a favouring influence. Gout does not, however, play a large part in this respect, while rheumatoid arthritis, considering its comparative rarity, seems to be strongly predisposing to it. After forty, gout plays a more important part, but has to share with other factors only 16 per cent of all psoriasis cases.

A few cases have developed soon after nerve shocks from grief, anxiety, etc.; but diseases of the nervous system play a much less important rôle than Polotebnoff claims for them. Speaking in general terms, it may be said that in a large proportion of cases beginning after thirty, defects of health, chiefly in the direction of faulty assimilation or arthritic lesions, are present, while younger subjects generally appear healthy, with ruddy, clear complexions, though in a good number even of these they are not up to their own highest standard, and any depressing influence will often determine an attack. The most striking example is in psoriatic women who suckle their children; this almost always leads to a severe and extensive outbreak.

Pathology.—The pathogeny of psoriasis is unknown. One theory is that it is the outcome of a neurosis; but even then parties are not agreed, some assuming that it is a vaso-motor defect, others that it is a central or peripheral trophoneurosis. The other theory is that it is due to an organism, doubtless schizomycetic. This is probably the correct view, but the symmetry and rapid widespread development so frequently seen postulate that the organism is in the blood when this occurs. The frequent occurrence of one or two patches remaining isolated for a long time, and then the rapid occurrence of generalisation in some cases, is suggestive of a primary invasion of the skin and subsequent absorption into the circulation, analogous to what occurs in pityriasis rosea. Cases of slow extension and of distal nail invasion may be explained by local inoculation.

The organism is probably a very common one, but only certain persons grow it, and heredity is explicable as an inherited tissue proclivity to the growth of the organism if exposed to it. Unna's view that psoriasis is the extreme end of the chain of the seborrhœic process does not meet with much acceptance.

Anatomically, the changes are those of moderate inflammation in the papillary layer of the corium with pronounced vascular dilatation; enormous increase of the horny layers with separation of the lamellæ; increased development of the prickle cell layers except over the papillæ; great down-growth of the interpapillary processes and consequent enlargement of the papillæ.

The interpretation of these changes is a matter of controversy. While some regard the processes as one of inflammation of a mild type, others say that the inflammatory changes are secondary to the rete changes, and one of the most recent observers asserts that the first change is in the horny layers, but this is improbable.

Diagnosis.—An ordinary case presents no difficulties, the symmetrical distribution predominating on the extensor surfaces, especially the elbows and knees, the discoid shape, well-defined border, and spongy crust of adherent silvery scales almost concealing the reddened base; and when the scales are picked off, the bright red, easily bleeding points which are exposed, and the dry character of the inflammation, make up a very characteristic group of symptoms.

Difficulties arise when some of the above symptoms are absent, ill-marked, or modified by various conditions.

Symmetry may be absent from some local cause, or in the early stage of the first attack, when it may be unilateral for some time. The discoid shape is often lost or obscured by coalescence. The crust of scales may be removed by washing, as on the hands, or by some application, before the case comes under observation.

In very pruritic cases, the patch may be scratched into an eczematous condition, so that it is no longer a dry inflammation, but very often only blood crusts are produced. The diseases most like psoriasis are, dry patches of eczema, especially seborrhœic forms: lichen planus patches, pityriasis rosea, squamous syphilides, tinea circinata, and some scaly forms of lupus erythematosus.

The patches of eczema, even when round and better defined than usual, as in the seborrhœic form, are never thickly covered with scales, and what there are, are in a single layer, and in no way conceal the ground colour. There are no bright red points, as in psoriasis, and serous exudation is readily produced by scratching. The ordinary weeping and crusted eczema is not likely to give rise to doubt.

Lichen Planus.—When lichen planus papsules coalesce into a patch, it becomes raised, well-defined, and somewhat scaly. It is never so scaly as psoriasis, it almost always has a violaceous hue, which should suggest the idea of lichen planus, and then careful search will almost always find some of the characteristic flat, angular papules, either near the patch or in some one or more of the favourite positions of lichen planus.

In the psoriasiform seborrhœic dermatitis, the resemblance is sometimes very close in some of the patches, but the distribution is different, the axillæ, trunk and groins are the usual seats of secretion, the scales are much less abundant, and are not in silvery crusts, but scanty and dull from the large admixture of fat, and seborrhœa capitis is almost sure to be present. The patches themselves are bright red and well-defined, but are often not circular.

Pityriasis rosea.—Here, although there are well-defined scaly discs in many of the cases, they are altogether more delicate than those of psoriasis. They are very little raised above the surface, the ground colour is paler, and the scales are very fine and scanty. The lower segments of the limbs are nearly always free, and the eruption is acute in development, and disappears spontaneously in a few weeks in most cases, although in some it lasts a few months.

Squamous Syphilides.—The small, scaly syphilide of the early secondary period is the most like an early psoriasis. In the syphilide, the distribution favours the flexor rather than the extensor aspect of the limbs, although not very decidedly; the eruption is more uniformly distributed than in psoriasis. The patches are always small, seldom over half an inch, the scales are scanty and dirty-looking, the ground colour, though fairly bright red at first, soon acquires a dirty, brownish-red tint. The eruption comes out in crops, so that all stages are present together; the faded eruption leaving very marked staining. Further, it is common to find more than one kind of eruption out at the same time, and there are almost sure to be the corroborative symptoms of syphilis in the glands, mouth, eyes, hair, etc.

The circinate and orbicular syphilide is something like the circinate psoriasis. Here again the distribution is different. The syphilide is most common at the nape, forehead, and around the nose, while it is absent from the usual psoriasis positions, and seldom attacks the limbs at all. The scales are less abundant, the rings are primary, and not therefore formed from a disc clearing in the centre, and being an early eruption corroborative symptoms are sure to be present.

A tertiary, circinate, scaly syphilide more closely resembles a psoriasis lesion, but the patches are generally few in number, not symmetrical, are not in the psoriasis positions, often on the face are more heavily crusted, and when the crust is removed ulceration is often present in some of the lesions, while the centre of the patch frequently shows atrophic scarring; scars of previous lesions also are often present.

Tinea Circinata.—The small number of lesions, the want of symmetry, and chance distribution, the scantiness of the scales, the finely papular border, and the very definite circular shape of the patch or ring, ought to prevent error. Scrapings well soaked in liquor potassæ would show the mycelium of the fungus.

Pityriasis rubra is only like the acutely inflammatory psoriasis, and can only be mistaken in the early stage. In advanced cases, the universality of the eruption, the large, flaky, loose scales, and the intensely red surface are distinctive. In acute psoriasis there are always some areas of healthy skin, the scales are smaller and less flaky, and all the symptoms are less developed or intense.

In all the above long list of diseases presenting more or less resemblance to psoriasis, errors arise from not taking all the points into consideration, and laying too much stress on one or two points of resemblance.

Prognosis.—The prognosis is good for any one attack if efficiently treated, but it is impossible to promise a permanent cure. The interval of freedom may be short or long, a few cases being several years without a recurrence. Immunity is most likely to be secured by persevering in the treatment until every spot has been removed.

Treatment.—A judicious combination of internal and external treatment is the most rapid method of removing the eruption, although there are many cases in which either method alone could be made successful in skilled hands.

There is no known means by which recurrence can be prevented, though by keeping the patient up to the highest standard of health attacks are less likely to occur, and by treating them promptly when they do appear the extent and severity may be minimised. None of the so-called specifics have a prophylactic action, and some are injurious at the developmental period. Complete removal of every spot gives the best chance for prolonged immunity.

Whenever any defective general health can be detected, the soundest practice is to treat that on the general principles of medicine whatever the condition of the skin may be; but inasmuch as in psoriasis under thirty there is often no defect of health discoverable, there are a certain number of drugs which experience has shown have a beneficial action on the diseased skin of many persons, although we cannot always explain their *modus operandi.*

For a long time arsenic was considered to be the only drug which had a material effect on psoriasis, and was *facile princeps.* Of late years thyroid extract, salicin, and its derivatives, and iodide of potassium in heroic doses have come in as valuable aids in the treatment of this often obstinate disease. Their indications and limitations are as follows:—

Arsenic.—While arsenic has an indubitable influence on the eruption, in many cases it must be confessed that it very often fails, and sometimes aggravates the eruption, both as regards itching and the evolution of fresh patches. In many cases, the drug must be given in large doses, and for a long period before any beneficial effect can be obtained. It has no prophylactic effect.

As regards the eruption, arsenic should not be given in the acutely inflammatory form, nor whenever the patches are very hyperæmic, show a great tendency to spread at the margin, or when new lesions are coming out rapidly.

Its most favourable effects are seen when the hyperæmia is moderate and the disease is stationary, or where there are only a few chronic patches.

As regards the patient, many are intolerant of it even in small doses, but while young people with good digestive organs can generally take fairly large doses for some time without conspicuous ill effects, it should not be given to persons with an irritable gastro-intestinal mucous membrane, or with defective powers of elimination.

It may be given either in a solid or liquid form by the mouth, and rarely by subcutaneous injection.

When the solid form is chosen the Asiatic pill is the favourite mode in Germany. ℞ Arsenious acid, grs. 8¼; powdered black pepper, grs. 67½;

gum Arabic and water sufficient to make a mass which is divided into 100 pills, each containing a $\frac{1}{12}$th of a grain. From one to three pills three times a day are given, in Germany, before meals, but it is much less likely to upset the stomach if taken after meals; if there is not a decided effect after 500 pills, arsenic may be considered to have failed.

In England arsenite of potash in the form of Fowler's solution is usually chosen, it has the advantage of being dilutable to any extent, and, therefore, less likely to upset the stomach; it contains 1 grain of arsenious acid in 110 minims, and the average dose is ♏v. three times a day, but it is best to begin with ♏iij. and gradually increase it to ♏x., according to the patient's tolerance. It should be given after meals and diluted with at least two ounces of water, and is often best combined with a bitter, such as tincture of hop, ♏xx.

If the patient can bear it, it may have to be taken for three months before striking benefit is observed; but it often has to be given up long before this, from its irritant effects on the gastro-intestinal canal, producing dyspepsia, griping, and diarrhœa, or from its producing other toxic effects, of which pricking of the conjunctiva and puffiness of the eyelids and a coated tongue are among the earliest symptoms, and should indicate a diminished dose, if not an actual withdrawal of the drug. The site of the patches is more deeply and persistently pigmented than usual in cases treated by arsenic. Patients who take arsenic for a long period become generally pigmented, while keratosic and warty thickenings develop on the palms and soles, but only in a few would such symptoms arise unless the dose was large or long continued. Epithelioma may develop on the warty thickenings many years after the arsenic has been left off, in one of the author's cases over forty years after.

Cacodylate of soda, a compound of organic arsenic, has recently been recommended as an improved means of giving arsenic in much larger doses than usual. One grain of the salt is said to be equivalent to $\frac{1}{10}$ of a grain of arsenious acid or 60 minims of Fowler's solution. Half a grain is the initial dose recommended, and it is said that as much as 3 grains a day may be taken with safety. The author, however, does not consider it a safe drug, and if given at all, $\frac{1}{16}$ of a grain three times a day is enough to begin with.

Thyroid extract as a treatment for psoriasis was introduced by Byrom Bramwell. While it has come short of what it was announced to be at first, in a moderate proportion of cases it acts most beneficially and more rapidly than anything else. It is, however, a remedy which should be given with care and under close medical supervision. It should not be given to old people or to those who have weak hearts. As regards the psoriasis it should not be given at the onset of the disease, nor whenever the eruption is undergoing development, as it often then spreads rapidly under thyroid influence. It is most likely to be of service in the same class of cases which are indicated for arsenic, but would not be worth trying unless the eruption was extensive.

The most convenient form is the five-grain tabloid; only one a day should be given for the first week, then two a day, and if the patient is tolerant, in about ten days the dose may be raised to three tabloids a day. It is seldom necessary to go beyond this, and unless the patient is in bed and under supervision is not safe. Headache and a pulse over 120 should be the signal to reduce the dose or stop the thyroid extract altogether. If after a month, there is not decided improvement the case is probably not suitable for the treatment. Iodothyrin and thyroidin are also given in smaller doses, but it is better to give the entire gland product.

Unfortunately, one can never be sure beforehand in any particular case whether it will be of service, and even in the same patient it will succeed in one attack and fail in another. This leaves only a very limited number of cases in which it will be successful, but in the best cases for it, improvement is often very rapid.

In the author's practice both arsenic and thyroid have been in great part superseded since he discovered the remarkable power of salicin and salicylates in removing the psoriasis eruption. As salicin is in most cases as efficacious as salicylate of soda, and less liable to upset digestion, it is the one to be chiefly used. It must be given in adequate doses. As a rule 15 grains three times a day in an ounce of water is the best dose to begin with, and as most people are very tolerant of it, the dose may be increased to 20 or even 30 grains, but its solubility is not more than 19 grains to the ounce, and it is better given in solution than in cachets or tabloids. In the large doses 4 minims of nux vomica tincture may be added to counteract any depression caused by the drug, but this is rarely seen. Salicin erythema eruptions are also rare, and in only a few does it disturb digestion or produce headache. It has the great advantage over arsenic and thyroid that it may be given with benefit in developing cases, and will often check the increase; and it disagrees in the above ways in so few cases that it is always worth trying, and while, of course, not always successful, it is so in a much wider range of cases than either of its rivals, with fewer drawbacks. It is more likely to produce speedy improvement in widespread hyperæmic cases than where there are a few chronic patches; it has also not much effect on psoriasis of the scalp. In suitable cases, the hyperæmia diminishes, the scaly crust becomes loose and then falls off, and gradually new scales cease to form, the patch clears up in the centre, the ring breaks up into fragments, which are best removed by local means. In the most favourable cases, this may be seen in from a month to six weeks, even when no local treatment has been simultaneously employed, but, of course, the majority take much longer. Like all other drugs it does not act as a prophylactic against future attacks. The action of salicin is, in the author's opinion, due to its breaking up in the organism into salicylic acid, and exercising a microbicide action in the blood or lymphatic circulation. Iodide of potassium in heroic doses has been strongly recommended by Greve, Boeck, Hasland, and others, and has undoubtedly good effect in some cases. Commencing with 10 grains three times a day, in a week it may be increased to 15 grains, and when tolerance is established the dose may be rapidly increased; as much as 750 grains a day have been given. In the author's opinion better results may be obtained by other means with less injury to the patient, for iodides have often a very injurious effect upon the gastro-intestinal and other mucous membranes, and it is not a drug to be given indiscriminately, for unless the heart and kidneys are quite sound dangerous iodism might ensue. It is uncertain whether its good results are due to its diuretic action or to the liberation of nascent iodine in the circulation.

Phosphorus, carbolic acid, antimony, and turpentine occupy quite a minor place compared to the previous drugs. The two latter are better than the first two, and are chiefly suitable for very hyperæmic cases. From 5 to 10 minims of antimony wine three times a day is the usual dose, and from 10 to 15 minims of turpentine suspended in mucilage; copious diluents, a quart of barley water or more a day being given to counteract the diminution of urinary water which otherwise ensues.

In very widely spread eruptions with great congestion, often the best treatment is large doses of quinine, gr. iij. to gr. v. three times a day, given in the acid portion of an effervescing potash mixture, gr. 22 bicarbonate of potash to 15 grains of citric acid being the usual proportion.

There are a few chronic cases which resist arsenic, thyroid, and salicin, even when combined with what is usually efficient local treatment. In these cases the intra-muscular injection of mercury is often most valuable. The author uses sozoiodolate of mercury dissolved with the aid of an equal weight of iodide of sodium; ¼ of a grain is injected into the buttock once or twice a week. Prault obtained good results in two cases by injecting yellow oxide of mercury ·05 gramme.

Mapother strongly advocates mercury salts internally for psoriasis.

Local Treatment.—This is of the highest importance, and in a large proportion of cases is sufficient by itself to remove the eruption. The indications are to remove the scales, diminish the hyperæmia, and then use a microbicide. In acute cases, when the first two indications are fulfilled, often nothing more is required. In chronic ones, when the scales have been removed, the microbicide treatment can be proceeded with at once.

The means to remove the scales are alkaline baths, ℥iv. of bicarbonate of soda to a 30-gallon bath, at a temperature of 95° F., the patient remaining in twenty minutes and rubbing off the scales after soaking. The bath may be repeated twice or thrice a week. Wet packs may be employed instead, but require the patient to lie up.

When there are only a few chronic patches, as on the knees or on the scalp, soft soap rubbed in with wetted flannel and then rinsed off is very efficacious, but is not suitable for actively inflammatory patches. It may be repeated every day, or three times a week, according to its effect. An improvement is, saponis mollis, spirit. vini rect., or eau de Cologne, partes equales; mix, and make a liniment.

In the more acutely inflammatory cases, wrapping the limb or body up in lint soaked in glycerini plumbi subacetatis ℥j., aq. distil. ℥vij., and covering it with oiled silk or hat lining, removes the scales and diminishes the hyperæmia, and will cure many patches.

Other applications suitable for acute cases, or whenever it is desired to reduce hyperæmia before resorting to special remedies, are calamine liniment, consisting of calamine gr. xl., zinci oxid. gr. xxx., lanolin ʒj., ol. olivæ and aq. calcis ad ʒiiiss., applied constantly by means of lint soaked in the liniment; or, covering the part thickly with Lassar's paste, with or without the salicylic acid, zinci oxid. ʒij., pulv. amyli ʒij., vaseline ℥ss., cover paste with butter cloth. Assuming that the hyperæmia has been removed by one of the above means, or that there is not enough to require such preliminary applications, what special application shall be selected?

All the special remedies are microbicides, and all have a more or less stimulating action. As a rule, the less hyperæmia there is, the more stimulating the remedy may be, but care must be taken not to irritate the patches too much, or the soothing treatment will have to be reverted to, and time be lost. Whatever the remedy, it must be rubbed in thoroughly to each patch, working especially round the edge. In extensive cases, an attendant may have to spend from two to three hours a day in applying the remedy, and this is the secret of success, together with adapting the remedy to the condition of each patch.

Only a few of the legion of infallible remedies need be mentioned as the survival of the fittest.

Chrysarobin stands first on account of its almost specific action on the diseased area, but it has serious drawbacks. It stains linen indelibly, and dyes the hair a purple-brown, and the nails also. It is also very liable to excite an erythema for a considerable distance beyond the point of application. This is sometimes so severe, and attended with such swelling, that it has been mistaken for erysipelas when situated on the face, where it also excites conjunctivitis. It should therefore never be used near the face, and the patient should be warned of the possibility of these disagreeables to clothes and person.

In covered places and suitable patches the result is almost magical, the disease being cleared off in a short time, leaving a white area on a red ground. Such a result is not always attainable, but a very satisfactory removal of the patch may often be obtained in a slower and less sensational manner. The stronger ointments, from gr. xx. to ʒj. to the ounce, are only suitable for indolent and pale patches. Since the author found that from one to five grains to the ounce of zinc ointment is signally beneficial in many hyperæmic cases its range of usefulness has been much extended.

When the surface is cleansed from scales, and the patch is pale, a paint may be used which is convenient to apply and does not stain; it is composed of chrysarobin gr. xx. to ʒj., chloroform[1] traumaticin ℥ix. The British Pharmacopœia traumaticin is made with bisulphide of carbon as a solvent, but its fæcal odour makes it an impracticable preparation. After painting for six days one coat over another the film may be peeled off, and a large part of the diseased area will be found to be cured. It is often advisable to wait a few days and apply an ointment before renewing the painting.

Pyrogallic acid is another valuable remedy, but it also stains, but to a less degree. It may be used in subacute cases, from 10 to 60 grains to the ounce of ointment, but it must not be used over a large area at a time, as dangerous symptoms may arise from its absorption. Dilute hydrochloric acid is said to be prophylactic and remedial for the toxic symptoms. For the face and other exposed parts those preparations which neither stain nor smell should be selected. They are resorcin, salicylic acid, thymol, which has the smell of thyme, but is cleanly, and naphthol, all gr. x. and upwards to the ounce.

Most of the mercurial ointments also are suitable for the face and for limited areas in other parts. They are the diluted nitrate ʒij. to the ounce, ammoniated mercury gr. xx. up to ʒij.; the yellow oxide, ʒj. to the ℥j., is stronger; the bichloride and biniodide, gr. j. and upwards.

They should only be rubbed on, never continuously applied. The ointment base is lard, lanolin, or vaseline, or a combination of them.

Many tar preparations are most valuable, and have stood the test of time, but their smell limits their use to those who can discontinue their social or business duties. They are oil of juniper pine (oil of cade), oil of birch (ol. rusci), creasote, all from 10 ♏ to 60 ♏ to the ounce. The old tar ointment is good, but seldom used, as it is dirty, as well as smelling strongly.

A 5 to 10 per cent watery solution of liquor carbonis detergens, or liquor picis carbonis, is often convenient for large areas for self-application, but is not so efficacious as inunctions. The pure solution may be used if followed by the continuous application of the glycerine of lead solution.

For the scalp, the spirit of soap liniment should be rubbed in with flannel dipped in hot water and then in the liniment, then rinsed out, and the ointment of perchloride or biniodide of mercury rubbed in every day.

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[1] To make this of proper consistence pure guttapercha ʒj. should be digested in chloroform ʒx. for two or three weeks, with agitation.

It should be thoroughly understood that there is no routine treatment as far as drugs are concerned. Their proper selection and adaptation, not only to each patient, but to each region or even patch of disease, only comes with practical experience, and after this their application must be thorough, and the strength or medicament altered according to the effect produced. It is always wise to begin with a weak preparation and increase the strength gradually. Where the patient will give himself up to treatment with a trained nurse, and the frequent supervision of an experienced practitioner, most cases of psoriasis, however extensive, can have the eruption removed in three or four weeks. Where the patient carries out his own treatment, hammering on with one prescription, three or four months to a year is the usual period, and even then failure often results.

Many patients, however, prefer treatment at spas, and when they are situated at high altitudes the invigoration of the climate is an important adjunct. In other cases, the results are not superior to what can be obtained at home if the patient will devote as much time to the treatment. They are best for wealthy patients, who cannot or will not give up their social or business engagements unless they leave home.

The baths are of two classes, thermal and sulphur. At thermal stations, such as Leuk or Aix-les-Bains, the treatment consists in prolonged immersion in weak alkaline hot waters. In sulphur baths, such as are found at Aix-la-Chapelle, Barèges, Harrogate, Strathpeffer, etc., in addition to the thermal action the sulphur acts as a microbicide. Very acute cases are not suitable for these baths, and they should always be taken under medical supervision, or they will often do more harm than good.

A few spas contain arsenic. They are: Levico, beautifully situated in the South Tyrol near Triente, 4880 feet above the sea level. It is the strongest arsenical spa known, and there are two sources; the strongest contains $\frac{1}{12}$ of a grain of arsenious acid to the pint and 4 grains of iron salts, chiefly persulphate. The dose is one tablespoonful. The weaker spring contains $\frac{1}{120}$ grain of arsenious acid to the pint and 8 grains of proto- and persulphate of iron. The imported waters can very well be taken, and as a matter of fact the water is brought down from a mountain behind Levico in pipes.

La Bourboule in the Puy de Dôme, France, being more accessible, is better known. The arsenic is in the form of arseniate of sodium, 28 mgrm. to the litre, or between one and a half to two grains to the gallon. The other constituents are lithium, sodium, and potassium chloride, sodium bicarbonate, lime, iron, and free carbonic acid. A large tumblerful is the average dose.

At Royat some of the waters are of a similar character, but weaker. The strongest is Saint Victor, which contains about one-sixth of the quantity of arsenic found at La Bourboule, but more iron.

At these spas, thermal treatment is usually combined with internal imbibition of the arsenical springs.

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Psorospermosis. *See* Parasites.

Pterygium. *See* Conjunctiva.

Ptomaines.—The term ptomaines was formerly applied to alkaloids produced by decomposition of the body tissues, but is now also applied to alkaloids found in the body during life. The term leucomaïne was at one time applied to the animal alkaloids produced during life, in contradistinction to ptomaines produced by decomposition of dead animal matter. Both these terms are now more or less obsolete, and the term animal alkaloid is universally applied. The nature and source of these complex and important substances is described under "Alkaloids" in Vol. I.

Puberty.

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Puberty is the time at which the reproductive organs enter the initial stage of potential or physiological activity. It is the beginning of the development from childhood into maturity. The time occupied in this development is long, in most people 12 or 13 years. It is known as adolescence, and it may be said to begin normally at from 12 to 14 or 15 years of age with the appearance of the first signs of puberty, and to end at the age of 25. As W. S. Christopher puts it, adolescence is the "epoch for the latentization of force for reproductive purposes, and this latentization requires a high nutrition and a relatively low activity."

In childhood the whole energy of life is directed towards growth, the building up of the bodily frame, bone, muscle, nervous tissue, etc. Children are more ready to suffer from malnutrition than adults, as they have not only to live but to grow, and the daily demands made on their nutritional powers are necessarily much greater than they are when growth has ceased. Long before young people have done growing the organs of reproductive life pass from quiescence to a certain measure of potential activity. From the date of this change, which we call puberty, the child has not only to live and to grow, but to develop his highest mental powers as well as his most complex animal functions. As perfect function cannot precede complete growth, it is clear that puberty does not mark the time at which the functional activity of the reproductive organs would be anything but harmful. Nature's care for the species rather than for the individual is shown by the age at which reproduction is possible. From the point of view of the individual the premature exercise of the generative functions is opposed both to perfect growth and to high development. Adolescence should be entirely occupied with growth and with the development of mind and body to the highest perfection possible to the individual.

Signs of Puberty.—In boys the "breaking" of the voice is one of the earliest signs of puberty. A boy's singing voice usually resembles a woman's soprano, but the note is less flute-like, more vibrant, and of clarionet quality. At puberty the larynx elongates, the vocal cords are at first relaxed, the voice is for a time hoarse. Then readjustment takes place, and the man's voice appears, usually an octave lower than the boy's. The speaking voice goes through similar changes; it becomes hoarse, and finally much deeper than in childhood. Concurrently the external genitalia grow and become more vascular. A considerable development of hair takes place on the face and pubes, and in a less degree on the arms and chest. Connected with this is a great development of the sebaceous glands of the skin, leading in many cases to an eruption of acne on the face and shoulders.

In girls menstruation is usually the first and most important sign of puberty. It occurs normally at varying ages from 11 to 16. As a rule it appears about 13. Within what may be called normal limits its early appearance is a sign of vigour, its postponement a sign of retarded and imperfect development, or of poor nutrition. Women of the best physical type are generally in advance of their age in youth and behind it in middle life. Menstruation in them begins early, it is painless and moderately profuse, and it lasts till 50. It is quite exceptional for menstruation to be painful for the first year or more of its occurrence. Dysmenorrhœa usually begins eighteen months or more after the first appearance of the catamenial loss. For a time, in most young girls, menstruation is the only sign of any considerable physiological change. They are still children in thought, feeling, and tastes. It is difficult to determine how much of the gradual change from childhood to adolescence is really due to the changed condition of the organs of the reproductive system, or how much of it ought rather to be attributed to the development of the nervous system generally and to the increasing influences of education and social and family life. In the opinion of the present writer a good deal of exaggeration is present in the writings of physiologists on this point. Girls of 14 and 15 are not, as a rule, troubled with anything that can be called sexual feelings. They are practically as free from them as they are at 7 or 8. Moreover, in the small minority of young women under observation who have never menstruated, and who presumably have either no ovaries or very undeveloped ovaries, the writer has not been able to recognise anything exceptional in their demeanour, in their desire for sympathy, affection, or admiration, or in their appreciation of pretty garments. If the entire mental organization of women were based upon sexual development, as some writers would have us believe, women who are without the most important part of the reproductive system ought to be much more unlike other women than they actually are. Similarly, in the curious type of women who may fairly be called "masculine"—the women who are genuinely, and from no affectation of their own, really like men in their habits of mind, their virtues and their defects—the writer has not been able to trace anything abnormal on the sexual side of their bodily development. On this side they are real women, on every other side they closely resemble men. It has to be admitted that the resemblance is a genuine one, and not the result of any "apeing" of men. Many women of this curious type have done their utmost to be ultra-feminine in dress, etc. We all remember Sydney Smith's inquiry, "Who is the gentleman in white muslin on the sofa?" in reference to a well-known woman who strove through a long life to be like the sex she belonged to physiologically, but not mentally. If the feminine qualities and characteristics are based solely upon the sexual organisation it is difficult to understand cases where mind, general formation of body, and temperament seem to belong to one sex, and the special distinguishing organs of sex to the other. They seem to suggest that the connection between the sexual system and the bodily and mental characteristics usually accompanying it may be less direct and immediate than is commonly supposed. In the two above-mentioned groups of what may be called "freaks" women are feminine without the fundamental feminine organs, or they are essentially masculine in spite of possessing them. Some correlation, which usually connects the sexual type of mind and body with the sexual organs, seems to be absent.

Precocious and Retarded Puberty.—Puberty is occasionally precocious in both sexes. In boys very marked precocity has often been part of general imperfection, both mental and bodily, as in Dr. Campbell's and Dr. Wood's cases. In girls it is not rare for menstruation to appear long before the usual date of puberty. In many of these cases the phenomena of menstruation stand alone and are not accompanied with other signs of precocious maturity. Children of from 1 to 7 years of age have had regularly recurring menstrual loss without any obvious abnormality of development. In another class of case, however, there has been seen very remarkable growth and size with development of the breasts and labia, and then precocious menstruation. Here there has been a physiological anomaly of development of which the precocious menstruation was but a part and a sign. Dr. Morse of Harvard has collected and published thirty cases of these two groups of precocious children. Among these there was one child of nine months old, another of seven months, who menstruated regularly. Both were abnormally large and intelligent even from birth. A post-mortem on one case showed ovaries which had ovulated regularly. One child, whose case is given by Dr. Morse, became pregnant in her eighth year, another at ten, and a third at eight and a quarter. In all these cases there was nothing strictly speaking abnormal except the precocity. They were anomalies of development. Where precocious menstruation is present without any general early maturity, the cause of the condition is even more obscure.

Cases are not uncommon in which, from change of climate, nervous shock, a severe illness at or about the time when puberty should have occurred, or from other causes, the normal rate of development has been checked, and menstruation is considerably delayed. As a rule in these cases, if there is good evidence of a sound general development, *e.g.* in breasts, pubes, etc., there is reason to expect menstruation to appear. If at 20 or more than 20 the breasts, etc., are infantile, it is probable that the ovaries are absent or imperfect. Where the ovaries are present, though functionless, menstruation may occur for the first time even at a very late age. Dr. Wolfe reports a case in which the patient menstruated for the first time at 43. She had been treated for some months when 19 years of age for amenorrhœa. Some years afterwards she married a widower with a family, never menstruated till eleven years later, when she was nearly 43. A severe fright from an idiot girl was followed at once by menstruation. This recurred irregularly for eighteen months when she became pregnant. In this case the fault must have been nervous. From some obscure cause the ovarian nerves were inhibited, possibly in a way analogous to the inhibition of common sensation, or of the special senses, in hysterical or in hypnotic conditions.

Disturbances of Health at Puberty.—In the great majority of cases the commencement of the change from childhood to adolescence involves no disturbance of health. Where the nervous system is sound, the nutrition good, and the habits of life wholesome, health may be expected at this as at other ages. This particular step towards maturity ought not to involve any more risk than the many previous steps from infancy upwards have done. Experience confirms this view. Every mother knows that a sound child of from 13 to 16 is a very much more robust creature than he or she was ten years earlier. He is much less often ailing, his life is more secure. She takes it for granted that the changes which puberty indicates will be accomplished without nervous or other disturbances, and in the case of healthy children her hope is almost always justified by the result. The case is, however, quite otherwise when the child inherits a bad nervous system, or when its nutritional powers are unequal to any extra stress being put upon them. Related to the fundamental changes accomplished at puberty, there is the correlative though not usually quite contemporary change of very rapid growth, and of an equally rapid development of the higher mental powers. Nervous stability is taxed in several ways at once. These conditions, however, belong more properly to adolescence than to the time of puberty itself.

In both boys and girls the time of greatest rapidity of growth is later than puberty, and it is probable that very rapid growth has more to do with the nervous instability of adolescence than anything else. Insanity is indeed rare at puberty, and markedly less rare six or seven years later. When present it is always the result of a strongly-marked inherited tendency. Dr. Clouston had only two cases of insanity at puberty in the Edinburgh Asylum out of a total of 1800 cases, and only twenty-two at the ages of 16 and 17. He believes insanity at puberty to be always hereditary, acute, remittent, not dangerous to life, and of good prognosis.

Of the less serious neuroses, epilepsy, chorea, and migraine are the most important, and they are also among the disturbances which most frequently seem to begin at or near puberty. Especially is this true of migraine and epilepsy. A large proportion of well-marked cases of migraine date from the age at which puberty usually appears. In women it may possibly be connected with the heightened arterial tension before menstruation, and with disturbance of the vaso-motor system as a direct result of the loss of blood. It is very unusual to hear of a true migraine beginning in adult life. In previously healthy girls the occurrence of menstruation, when the loss is normal in amount and regular in its return, seems to produce no evil effects. If, however, the loss is excessive, or very scanty, or quite irregular, the general health is usually affected disadvantageously, coincidentally, perhaps, rather than consequently. The appetite often fails, and then at a time of very rapid growth the nutritional power is diminished and anæmia results. The power of assimilating a liberal allowance of nutritious food is never more valuable than in a girl of 15 or 16 when, along with a marvellous rate of growth, the organs of reproduction are being gradually matured and perfected, and their nervous mechanism elaborated, and, as it were, trained into harmonious working. For all this a high degree of nutrition is wanted. The change started in girls at puberty, without suffering and without any disturbance of health, is frequently checked a few years later by conditions which unfavourably affect the nervous system or the nutrition. A familiar instance of this is the bad effect on a girl's health which so frequently results from sending her abroad at 16 or 17 years of age. A visit to Germany especially very often upsets a girl's health to a very serious extent. The food is distasteful, the houses are hot and close, there is very little out-door life, very few games, and she is home-sick and solitary. The nerves connected with the system then in process of development are often the first to break down as a result of poor nutrition and a generally depressed vitality. Mothers are apt to be unduly anxious about the first appearance of menstruation, and not nearly anxious enough to maintain vigour during the important years which immediately succeed it.

Hygiene of Puberty.—No special rules are required at this age for either boys or girls. They both need a healthy, active life, with much open-air exercise, plenty of good food, and plenty of occupation. The discipline and brightness of a good school are, as a rule, much better for girls as well as boys than the indulgence and absence of systematic playground life which are involved in education at home. All good girls' schools of the present day make almost as much use of playground games as boys' schools do, and with similarly good results. Young people of that age are best with very little leisure, with their whole time so occupied with a disciplined routine of work and play that there is no opportunity for lounging about and sentimentality, and with a large amount of social and amusing exercise. Girls who enjoy out-door games usually eat well, and if they do Nature will take care of the due development of their reproductive organs. The danger of too much exercise, especially when it is out of doors, is far smaller than the danger of too little, and the regulation of exercise may safely be left to the discretion of the schoolmistress if she is fit for her work.

Parents are often puzzled as to how far it is well to explain the elementary facts of the physiology of reproduction to girls and boys at about the age of puberty. Much depends on the relations between the parent and child; some parents are much more intimate with their children than others. A certain degree of reserve on such subjects ought certainly to be maintained; but it is probably always best for fathers to speak to sons, and mothers to daughters in a way which shall enable the child to understand the elementary facts of life, and to look upon them with reverence. The study of botany is perhaps the best way of introducing to children the idea of sexual differences, and from botany the step can be taken to the natural history of animals, and so to human physiology. It is certainly desirable for boys to be warned as to the great danger of loss of self-control, and of any premature and irregular exercise of the reproductive function. Girls, as a rule, need such warning far less than boys, and it must depend on the discretion and insight of their mothers to give it or to withhold it.

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Public Health.—The following is a list of the more important articles dealing with questions of public health :—

Air, Examination of.
Disinfection.
Food.
Hospital.
Infection.
Meteorology.
Quarantine.
Ship Hygiene.
Sewage and Drainage.
Trades, Dangerous.
Ventilation and Warming.
Vital Statistics.
Water.

Pudenda, Ulcerating Granuloma of the.—The distribution of this disease is not yet fully known. It occurs in British Guiana, where it attacks the pudenda of the coloured population and half-breeds. Women are rather more frequently attacked than men. Dr. Daniels states that he has seen a similar disease in Fiji amongst the Melanesians from the New Hebrides and Solomon Islands. It was there a chronic disease, unaffected by antisyphilitic treatment, and was locally contagious, or at least affected opposed surfaces. The present writer met with probably a dozen cases in Darfour and in the Bahr-el-Ghazal district of Central Africa. Dr. J. H. Conyers, who has had experience on the Gold Coast of West Africa, never saw the disease there. Dr. Kennard divides the affection into three classes—specific, tubercular, and malignant—but it is probable that these are only phases of the same disease. The disease attacks individuals from adolescence to old age. It is rarely, if ever, cured, and specific treatment has no influence upon its progress, although it may be useful in cases which are complicated with syphilis. Fifty years ago the disease seems to have been exceedingly rare.

There is no evidence that this affection is hereditary.

The disease usually commences as a simple pimple situated somewhere in the groin or behind the scrotum, or somewhere on the genitals. There is great itching, and buboes form. The patients scratch themselves, and the tissues break down and discharge a foul-smelling purulent fluid. An ulcer rapidly forms, having abrupt edges which are more or less indurated. There is little or no congestion of the surrounding skin. The affection may either begin on the skin or the mucous membrane; it does not affect the glands, bones, or subjacent tissue, but spreads in the dermal and sub-dermal tissue. It has a marked preference for the neighbourhood of the hair follicles and for the sebaceous and sudoriferous glands, at any rate in its advanced condition. The disease does not markedly affect the general health, and is not associated with any particular diathesis.

Microscopically the disease appears to be allied to lupus erythematosus, but there is a want of symmetry, and it is more superficial in character than that disease. It spreads very slowly—for instance, in a case which was seen in 1890 it was situated behind the scrotum, in 1892 it had spread round the anus, and in 1896 it had extended backwards to the coccyx.

No characteristic micro-organisms have been found in connection with this affection, simply micrococci staining deeply by Gram's and Löffler's methods. The nodules which exist on the margins of the ulcers are composed of round cells with large but usually badly stained nuclei contained in a delicate reticulum of fibrous tissue, which is covered by epithelium. The nodules merge gradually into a subjacent, dense, fibrous stroma, in which small masses of similar rounded cells are imbedded. The growths are very vascular and the capillaries much dilated, but there are no hæmorrhages (J. Galloway).

Treatment.—This is very unsatisfactory. Tonics if necessary, but, as before mentioned, specific treatment is without effect. The local treatment consists of great cleanliness and the application of caustics. Salicylic acid, 30 or 40 grs. to creasote ointment 1 oz., may be used. This causes severe pain for one or two hours, but it does not cure the patient, as if the treatment is stopped the ulceration proceeds. Scraping the diseased part with a Volkmann's spoon is sometimes useful, but the only chance of cure is the free excision of the initial pimple. Usually the disease has progressed too far for this when the patient comes under observation.

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II. MANAGEMENT OF THE PUERPERIUM

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THE puerperium is the period of recovery from childbirth, and is also known as the "lying-in." It may be said to begin with the expulsion of the placenta, and to comprise clinically the first month and anatomically the first six weeks after delivery. It possesses a twofold interest: from the physiological and anatomical standpoint, remarkable changes in the maternal system supervene on the completion of labour; from the clinical standpoint, the management of the puerperium requires the most careful attention, in order to shield the patient from present danger and to avert harmful results in the future. This natural division of the subject will be followed here, on the lines of the index.

I. Changes in the Maternal System

The rapid transition from the condition of carrying and nourishing a child *in utero*, with the modifications of nutrition, circulation, and excretion entailed thereby, to the condition in which mother and child have an independent existence, has a marked influence on the whole maternal system; and this influence is accentuated by the changes incidental to the progress of involution and the establishment of lactation.

A. *Physiology of the Puerperium.*—The beginning of the puerperium is characterised by the effects of the effort of labour. Fatigue, which may amount to prostration, is combined with the feeling of rest and relief following exertion and pain; the skin, pulse, and temperature testify to the recent muscular efforts, and the patient is usually content to lie in a condition of bodily and mental inactivity. The immediate and later systemic changes now demand our consideration.

1. *Temperature and Skin.*—Immediately after delivery there is a rise of temperature, which is usually slight, but which varies with the characters of the labour, and especially with its duration. From some observations on 600 cases at the General Lying-in Hospital, made for the purpose of ascertaining what relationship existed, I found (1) that the duration of the first stage of labour has only a slight influence on the subsequent temperature, except in those cases where the membranes rupture very early; when this occurs, and the first stage lasts one or several days, the temperature after delivery is often high, even when the second stage is rapid.

(2) The influence of the duration of the second stage is more marked; the longer the second stage, the higher is the temperature after labour. The time of day at which delivery takes place has a slight influence on the temperature, but less than is attributed to it by Schroeder. To estimate this factor under conditions as similar as possible, I analysed 300 normal cases of multiparæ in which the second stage of labour lasted less than an hour. Dividing the twenty-four hours into periods of four hours each, 50 cases were taken of delivery within each period, and the average temperature in each group of 50 cases was obtained, coming out as follows:—

Hour of delivery:	12 night to 4 A.M.:	Temp. 99°	12 noon to 4 P.M.:	Temp. 98·7°
	4 A.M. to 8 A.M.:	„ 98·6°	4 P.M. to 8 P.M.:	„ 98·9°
	8 A.M. to 12 noon:	„ 98·6°	8 P.M. to 12 night:	„ 98·6

After the administration of chloroform during labour the subsequent temperature is relatively low, even when the second stage has lasted long, and has been terminated by forceps.

The temperature during the remainder of the lying-in period presents no difference, in normal cases, from that of an ordinary healthy person.

It was formerly taught (3) that during the first twelve hours the temperature rises, that it falls during the next twelve hours, and that, after remaining stationary thereafter for twenty-four hours, there is a second rise, corresponding to the development of lactation. This rise was said to last two days, and to then give way to the ordinary temperature, which was somewhat higher than that of perfectly healthy persons, reaching a maximum of 100·5° F. (38° C.). So also E. S. Tait (4) found that the highest temperature occurred on the third day, and he attributed the rise to the onset of lactation. The teaching of modern text-books is that, while the temperature of the lying-in woman is easily disturbed, it is not normally different from that of a healthy person (5). Galabin (6) was among the earliest to express this view. He says: "It does not appear that any notable rise of temperature should be regarded as necessary, or absolutely normal; and the elevation about the third day is probably due, much more often than was formerly supposed, to a slight septic or traumatic disturbance." Recent American, French, and German opinions are in accord with those of English writers on this point. Varnier states categorically that "the so-called milk-fever is nothing else than an attenuated form of puerperal infection." It is not necessary to multiply quotations, and I will content myself with supporting the modern view on the careful observations of Probyn-Williams and Cutler. Observations made on 100 consecutive uncomplicated cases led them to the conclusion that the average temperature during the lying-in varies between 98° and 99° F.

Rupture of the perineum was in the former days a frequent cause of rise of temperature. Tait (*op. cit.*) found that, in 23 cases of more or less severe tear, the average highest temperature was 103·8°; in 7 cases of slight tear, 102·6°; and in 11 cases of labial tear, 103·7°. With a better asepsis these temperatures disappear. Probyn-Williams and Cutler found that, in 15 consecutive cases of rupture of the perineum, requiring one or more sutures, the average of their temperatures did not differ to any appreciable extent from the normal.

W. S. A. Griffith considers that normal cases are those in which the temperature does not exceed 99°, and finds that on this basis about 60 per cent of cases may be regarded as normal.

There are two reasons why the belief in "milk-fever" should have prevailed so long. In the first place, before antisepsis was introduced into midwifery, a mild degree of sapræmia or of septic infection often occurred; and the usual time for the manifestation of these conditions is from the second to the third day, *i.e.* about the time that the breasts are taking on a fuller activity. In the second place, as Griffith points out, there is a direct connection between septic conditions of the uterus and a form of mastitis; and pyrexia, associated with a blush on the breasts, may be, and often is, due to some putrid clot or portions of placenta.

The skin of healthy lying-in women is more moist than in the non-puerperal condition, and indeed this is a feature that persists during lactation. It is not, therefore, the result of the muscular efforts incidental to delivery. It is probably correlated with the activity of the breasts, to which the glands in the skin have an ancestral relationship. No doubt an additional cause for increased activity in the skin is to be found in the fact that the skin shares with the kidneys the duties of increased elimination of waste tissue-products resulting from involution.

The pigmentation of the skin brought about during pregnancy usually fades fairly rapidly, and may have disappeared almost completely in a few weeks. The striæ lose their reddish tinge, and eventually become white and opaque.

The development of mammary functions by the skin of lying-in women was first described by Champneys, who found that in 27 out of 377 women confined at the General Lying-in Hospital, lumps appeared in the axillæ, from which a milky secretion could be expressed. In half the cases they were bilateral. These lumps are situated in the skin, and, unlike lymphatic glands, can be raised and isolated from deeper structures. They are soft, flattened, without obvious nipple, pore, or duct. They are limited to the hair-covered surface, and range in size "from the smallest perceptible to that of an egg." They are commonly first noticed on the third or fourth day after delivery, and their course coincides generally with that of the breasts, enlarging and becoming tense and sometimes tender about the third day. They sometimes enlarge, and occasionally become painful at the beginning of a subsequent pregnancy, or during menstruation. The secretion does not flow spontaneously; but when squeezed out it appears successively as granular *débris,* like the secretion of sebaceous follicles; then colostrum, and then milk. At first these lumps were thought to be associated with sebaceous glands, but a later investigation by Champneys and Bowlby has shown them to be modified sweat-glands, the sebaceous glands being unaltered.

2. *Circulatory and Respiratory System.—The Heart.*—During the later months of pregnancy the heart usually becomes displaced slightly to the left; but with the emptying of the uterus and the diminution of intra-abdominal pressure, it is able to resume its normal position. The base of the thorax at the same time tends to return to its normal width; it does not, however, do so entirely, except under the influence of artificial compression. A second important change is the disappearance of the hypertrophy that is found during pregnancy; this involution of the cardiac muscle is commonly associated with a soft blowing murmur replacing the first sound as heard at the apex. This was first described by Angel Money, and has been confirmed by later observers. Dakin found it to be present in 57 out of 100 cases specially examined at the General Lying-in Hospital.

The Pulse.—Retardation of the pulse during the lying-in was incidentally noted by R. Whytt in 1765; Montgomery recorded, in 1857, three cases in which the pulse was 40 to 44 on the day after delivery, rising about 10 beats a day till it returned to normal. Two of the cases were multiparæ, and one a primipara. He mentioned that he had seen many other cases of this phenomenon, of which he was unable to offer any explanation. M'Clintock, in 1861, stated that, in a large proportion of cases of normal convalescence, the pulse scarcely deviated at all from the standard of health: with the reaction succeeding to the shock of parturition, and with the coming of the milk, there might be a rise of a few beats; but even this temporary acceleration was more frequently absent than present. He continually met with cases in which the pulse did not exceed 72 all through childbed; and many other cases he had met with where it was as low as 60, 54, 48, and even 44. But this morbid slowness he regarded as constitutional, and not depending on any condition peculiar to childbed; and he added that these patients recovered well.

A more detailed study of the question was made by Blot in 1864. The following is a *résumé* of some of his conclusions:—Slowing of the pulse is generally observed in *healthy* lying-in women. The patients on whom he made his observations had, apart from the puerperal state, an ordinary physiological pulse-rate. Most frequently the pulse-rate oscillates between 44 and 60; three times he saw it fall to 35. The slowing is not influenced by diet, by uterine contractions, nor by the duration of the preceding labour; and it persists during the time often improperly described as that of "milk-fever." It is more often found in multiparæ. It generally begins in the first twenty-four hours after labour; becomes more pronounced, then remains stationary, and finally disappears gradually; the duration of the slowing is usually from 10 to 12 days. It is a very favourable prognostic sign. It is not to be explained by nervous exhaustion, for sphygmographic observations undertaken in conjunction with Marey showed that it is related to the increase in arterial tension which follows labour. Louge, whose conclusions agree in the main with those of Blot, describes three types of the puerperal pulse: in the first type it oscillates between 72 and 80, and is never slower; in the second the general rate is 72 to 80, but it may drop at times to 60 or 58, returning to the normal; in the third type the pulse becomes gradually slower, till it oscillates between 46 and 50, the maximum slowing being on the seventh day. Olshausen found that in 348 cases the pulse-rate was as follows:—

Over 60 in	128	cases, or	36·8	per cent
51-60 in	164	„	47·1	„
41-50 in	53	„	15·3	„
40 or under in	3	„	0·8	„

Hence a pulse below 60 was found in 63 per cent of cases. Falaschi described it as occurring in 25 per cent of cases; Louge found it in 33 per cent of multiparæ, and in 25 per cent of primiparæ. Blot, on the other hand, considered it to be the general rule. The above conclusions have become crystallised in the teaching of most of the text-books of midwifery. Thus Spiegelberg says: "The pulse-rate, which had increased during labour, diminishes immediately after it, then rises again, and on the second, third, or fourth day becomes markedly slowed. The rate then varies between 44 and 70; indeed, a frequency of less than 40, even of 30, has been noticed; the usual figures are 44, 48, and 56."

Within the last few years the older teaching has been challenged, notably by Probyn-Williams and Cutler, and by Heil. From an investigation on 100 cases at the General Lying-in Hospital, Probyn-Williams and Cutler found that the average pulse-rate during the puerperium was never lower than 72, and was often nearer 80 than 70; not one case presented features corresponding to the above description by Spiegelberg. On examining the records of 20 cases at Queen Charlotte's Hospital, their conclusions were confirmed. Their 100 cases presented the somewhat curious feature that the pulse-rate was higher in the morning than in the evening. Heil's investigations also comprised 100 cases; he found that in only 12 per cent of cases was the pulse-rate less by at least 10 beats during the lying-in than during pregnancy. He concludes that it cannot be admitted that there is during the puerperium a physiological retardation of the pulse to anything like the extent generally taught; for though the pulse may be slow, the same thing may occur during pregnancy or in ordinary health; it is in no way characteristic of the lying-in period.

In the face of these conflicting views, Varnier set himself to investigate the matter afresh; and his observations led him to the conclusion that in 72 per cent of cases there was an undeniable slowing of the pulse during the lying-in. We must necessarily conclude from these diverging results that the pulse-rate during the puerperium presents great variations, depending no doubt in some degree on varying conditions of observation. Investigations on a more extended scale are required. For the present, the view that most nearly expresses the results of the majority may be considered to be this: that *during the lying-in period the pulse-rate is frequently lower than in the non-puerperal state, and almost always lower than during pregnancy; the most common pulse-rate is* 60 *to* 70, *and the instances in which it is lower than* 50 *must be regarded as quite exceptional.*

Until slowing of the pulse has been unequivocally demonstrated to be the general rule, it is perhaps futile to discuss at length the cause of such slowing. It will suffice to enumerate some of the views propounded. Thus it has been attributed to the mental and physical rest of the puerperal woman; to impoverishment of the blood from abundant losses;

to increased arterial tension (Blot, Marey, Hémey); to the horizontal position (Fritsch); to altered innervation (Löhlein); and lastly to fat in the blood derived from the involution of the uterine muscle (Olshausen).

With regard to arterial tension during the puerperium, there is again a diversity of opinion. Fritsch stated that it is diminished, and Meyburg confirmed this view; on the other hand, Probyn-Williams and Cutler support the teaching of Blot and Marey that it is usually raised. The differences of opinion may be due in some measure to want of discrimination between the immediate effect of delivery on the tension, and the condition when that effect has passed off. According to Probyn-Williams and Cutler, the tension varies considerably during the first twenty-four hours after delivery, being sometimes increased and sometimes diminished; but at the end of twenty-four hours it has always increased so as to equal, or more often surpass, the tension during labour. The duration of the increase varies, but is usually longer in multiparæ. A rise of temperature, even though slight, rapidly reduces the tension.

The œdema and the *varicose condition of the veins* in the vulva and legs, which are so often present in the later months of pregnancy, usually rapidly subside after delivery.

The respiratory rhythm is said by some writers to become slowed during the puerperium. In Probyn-Williams and Cutler's cases this was not the case; the average rate was 20 to 22, and followed the pulse-rate in being higher in the morning, rather than the temperature, which was higher in the evening. The capacity of the lungs is not usually altered; for although the diaphragm has a greater range of movement after the emptying of the uterus, this is neutralised by the narrowing of the base of the thorax, which had been expanded during pregnancy.

3. *The Digestive System.*—For the first few days after labour there is a loss of appetite, which no doubt has a physiological relation to the diminished demand on metabolism, when the mother no longer has to nourish the fœtus *in utero*, and before the new claim of lactation is established. On the other hand, thirst is increased owing to the rapid elimination of fluids by the skin and kidneys. The action of the bowels is nearly always sluggish; this is attributed to the patient's quiescent condition, to the small quantity of food taken, to the increased activity of the other emunctories, and to the relaxation of the abdominal walls. Another factor which, it seems to me, cannot be ignored, is the diminished intra-abdominal pressure, which results in a temporary vaso-motor paresis; as a consequence of this the innervation of the intestines remains in abeyance, and the "abdominal pool" becomes filled by dilatation of the vessels in the splanchnic area.

4. *The Excretory System.*—For about the first week after labour the quantity of urine secreted is increased. This increase relates mainly to water, for in respect of solids the total quantity eliminated shows no increase. Thus the absolute quantity of urea and of chloride of sodium is unaltered, whilst there is an actual decrease in the quantity of phosphates and sulphates. The specific gravity ranges about 1210 to 1215. Peptone, derived from the uterine involution, is commonly present for several days. In view of the researches of Vicarelli and Knapp on acetonuria in pregnant women, which led these investigators to the conclusion that the presence of acetone in the urine was pathognomonic of death of the fœtus, it is interesting to note that Mercier and Menu found acetone in the urine of three out of six normal puerperal women. There has been a considerable discussion as to the presence and significance of sugar in the urine since this phenomenon was first demonstrated by Blot in 1856. Blot held that sugar

existed normally in the urine of all lying-in and suckling women, and in a certain number of pregnant women, and considered that the sugar gave an indication as to the quality of the milk. At first these views were not universally accepted. Wiederhold (1857) ascribed the reaction to mucus, and Leconte (1857) to uric acid. Riedel (1858), from the examination of eleven puerperal women, concluded that sugar was not normally present in the urine. On the other hand, Kirsten (1857) confirmed Blot's results, except that he affirmed that the amount of sugar was inversely proportional to the quantity of milk; and Brücke (1858) concluded that sugar was normally present in the urine not only of the nursing woman, but also of the healthy man; whilst Iwanoff (1861) took an intermediate position, saying that sugar was frequently but not constantly found. Lecocq (1863) held much the same view as Brücke, except that he thought that, whilst sugar was normally present in the urine, it was found more abundantly in the urine of nursing women. Chailley (1869) found sugar in 3 cases out of 13. De Sinéty (1873) showed that glycosuria could be produced at will by sudden suppression of lactation, and that it disappeared when the secretion and excretion of milk were balanced; and in a later communication (1876) he showed that the sugar might have other than a mammary origin, for the veins of the gland contained less sugar than the arteries. Hempel (1874-75), from an analysis of 12 cases, concluded that sugar was always present at some stage of lactation; but Gubler (1876), Johannowsky (1878), and Verneuil (1882) returned to the view of Kirsten, saying that sugar was only found when lactation was interrupted. Kaltenbach (1877), Spiegelberg (1877), and Hofmeister (1878) all found that sugar was a constant constituent of the urine of lying-in women. To Hofmeier and to Kaltenbach is due the credit of the independent discovery that the sugar was lactose. Spiegelberg regarded the presence of sugar as due to a "resorption diabetes." Ney, whose observations were more extensive than any before or since, embracing 24 pregnant and 148 lying-in women, also considered that the glycosuria was a form of "physiological diabetes" characteristic of good nurses. M'Cann and Turner carried out an admirable investigation on 100 cases, entailing 1400 analyses of the urine, and their results, which have lately been confirmed by Keim, may be taken as representing the present state of our knowledge of the subject. Lactosuria was observed in every case. As a rule, lactose was present every day after lactation. The quantity varied from ·18 to ·69 per cent, the average being ·35 per cent, *i.e.* 1½ grain to the ounce. The date of the first appearance of lactosuria was found to be as follows:—

1st day (day of labour)	29 per cent	4th day	11 per cent
2nd „	27 „	5th „	2 „
3rd „	26 „		

The late appearance of lactose on the fourth and fifth days can be explained by the fact that the supervention of lactation is delayed in these cases. M'Cann and Turner give two interesting tables to show the relation between the days when the largest amount of sugar is present and the day when milk first appears in the breasts. I have combined these tables to bring out the relation more forcibly.

	Percentage of cases when milk first appears in the breasts.	Percentage of cases when the largest amount of sugar is present.
1st day	—	1
2nd „	5	5
3rd „	10	46

	Percentage of cases when milk first appears in the breasts.	Percentage of cases when the largest amount of sugar is present.
4th day	26	39
5th ,,	26	6
6th ,,	8	1
7th ,,	5	
8th ,,	3	
9th ,,	4	
10th ,,	5	
11th ,,	3	
12th ,,	2	
13th ,,	2	
14th ,,	1	

Thus the mammary glands being in a state of great activity on the third and fourth days of the puerperium, milk is rapidly formed, and thus distension of the breasts soon occurs; at the same time milk-sugar is absorbed into the blood, owing to the excessive production or diminished outflow of milk, and this excess of milk-sugar is excreted by the urine, and is thus found in largest amount on the fourth and fifth days. In most cases, after this period, the amount of sugar remains constant if the milk be excreted uninterruptedly, and if the daily quantity be not excessive, *i.e.* if the production and exhaustion be equal.

The most important factor in causing increase of lactosuria is distension of the breasts, leading to absorption of milk-sugar into the blood. The same effect is produced by the application of belladonna to the breasts. Next in importance comes the excessive production of milk. But although excess of milk is associated with increased lactosuria, the quality of the milk may be inferior, except in regard to its richness in lactose. Hence the indication as to the value of a wet nurse, which Blot thought could be found in the amount of sugar in the urine, is not to be relied on. Increased lactosuria also follows the reflexly increased secretion brought about by putting the child to the breast.

The Bladder.—Although an increased quantity of urine is secreted in the early days of the puerperium, the bladder usually displays a marked inactivity, with the result that retention of urine is generally met with. The principal reason of this is probably the same as is found operating in reference to the bowels, namely, diminished intra-abdominal pressure and laxity of the abdominal walls. A contributory cause is found in the bruised sore condition of the bladder and urethra, for in the vesical portion of the latter fissures are often produced during labour (Spiegelberg). This acts in two ways: a reflex inhibition of the bladder muscle is brought about, and the patient dreads to pass water. Recht made observations on 224 women confined at term in the Clinique Baudelocque, and found that the time that elapsed between labour and the first micturition was as follows:—

Broadly expressed, the bladder was first emptied:

In the first 6 hours . .	in 51	cases, or	22·76	per cent
From the 7th to the 12th hour	in 79	,,	,, 35·26	,,
,, 13th ,, 18th	,, 46	,,	,, 20·54	,,
,, 19th ,, 24th	,, 33	,,	,, 14·75	,,
,, 25th ,, 36th	,, 15	,,	,, 6·69	,,

The separate examination of primiparæ and multiparæ shows that retention is more pronounced in the former. The difference is probably largely accounted for by the greater extent and frequency of local injury or bruising.

	Primiparæ.	Multiparæ.
First micturition in first 12 hours . .	40·77 per cent	72·79 per cent
„ „ from 13th to 24th hour . .	48·54 „	23·97 „
„ „ „ 25th to 36th hour . .	10·67 „	3·30 „

We shall return to the question from the point of view of treatment when discussing the management of the puerperal state.

5. *The Nervous System.*—For some hours after a normal delivery the patient lies very quiet; the mind is peaceful, owing to the feeling of satisfaction that labour is finished and the child is born. The physical condition resembles that of great fatigue, and after a prolonged labour it may even border on shock. Churchill thus describes it: "After a normal labour there is a condition of nervous shock which lasts for a few hours; during this time the sensibility of the brain is diminished, but the organs of sense are more sensitive. The eye has lost its brightness, and expresses languor and exhaustion; but it is more intolerant to light, as the ear is to sound. After obstetrical operations the shock may be much more pronounced." This passing phase of shock, if present, soon gives place to a condition of exalted irritability of the whole nervous system; so that very slight physical or emotional causes are sufficient to send up the temperature and otherwise disturb the patients. In those of a hysterical or highly-strung temperament the border-line between sanity and insanity may easily be reached, and even overstepped. Normally this condition subsides within a week or ten days.

6. *Lactation.*—For the first twenty-four hours after delivery the breast-secretion is much the same as in the later part of pregnancy, and is known as colostrum. The true milk-secretion begins most frequently on the third day. According to M'Cann and Turner's table, quoted above, the date of the first appearance of milk in the breasts presents the following relative frequency:—

1st day in 1 per cent	3rd day in 46 per cent	5th day in 6 per cent
2nd „ „ 5 „	4th „ „ 39 „	6th „ „ 1 „

Lactation is established rather later in primiparæ than in multiparæ. Its onset is marked by swelling and tenderness of the breasts; the superficial veins are distended, the axillary glands are enlarged, and the lymphatics leading to them are readily felt. The more pronounced these features are, the greater are the pain and the tenderness experienced; and when the local disturbances are considerable they are accompanied by general malaise, loss of appetite, and some rise of temperature. As we have remarked, the nervous system of the lying-in woman is excitable, and it is not therefore surprising that the temperature should show a slight rise when the breasts are very painful. This rise does not indicate that there is "milk-fever"; it is generally agreed now that no such thing exists. Moreover, as Griffith points out, it is important to remember that a rise of temperature which coincides with the onset of lactation may really be due to septic absorption from the genital canal, the effects of which appear about this time, and that disturbances in the breasts may actually be the result of such absorption.

At the outset, the secretion of milk, though independent of, is favoured by the reflex stimulation of the gland through the nipple when the child is applied to the breast. Thereafter, as long as suckling is continued, the supply, under ordinary conditions, is kept up for nine or ten months. Sometimes, from constitutional causes, such as weakness, faulty diet or metabolism, or from no apparent cause, the supply runs short after three or six months; or, while the quantity is unchanged, the quality deteriorates, so that the child does not thrive. In other cases suckling is persisted in for twelve or fifteen months, and exceptionally for an even longer time. The weaning of the child is commonly followed within one or two weeks by diminution and disappearance of the milk. As long as lactation lasts, menstruation is usually in abeyance; but not infrequently the menses reappear at the fifth or sixth month, and occasionally a woman menstruates all through lactation. Conception during this period is correspondingly rare.

Characteristics of Colostrum and of Milk.—Colostrum is a turbid pale yellow fluid, alkaline, and slightly viscid from the presence of mucin. Chemically, it contains more fat, sugar, and inorganic salts than are found in the milk secreted later; and, in contradistinction to the latter, it contains a considerable quantity of globulin and very little caseinogen. Microscopically, it is characterised by fat globules, mucous corpuscles, shed epithelium, and colostrum corpuscles. The latter are swollen rounded cells loaded with fat globules; they are cast-off cells of the alveolar epithelium, and by suitable reagents can be shown to possess a nucleus, and to exhibit amœboid characters under certain conditions. Colostrum has a mild laxative action, due, according to Winckel, to its relatively large quantities of phosphate of calcium, and chlorides of sodium, potassium, and magnesium.

Human milk has a bluish-white tinge as compared with cow's milk, and, like the latter, has a neutral or faintly alkaline reaction. In carnivora the milk is acid. The chemical composition of human and of cow's milk is given by Frankland as follows:—

	Human Milk.	Cow's Milk.
Proteids (chiefly caseinogen) . .	2·7 per cent	4·2 per cent
Fat	3·5 „	3·8 „
Sugar (lactose)	5·0 „	3·8 „
Salts	0·2 „	0·7 „

Microscopically, milk presents the characteristics of an emulsion, with very finely divided fat globules and a few epithelial cells. Colostrum corpuscles are not found after the first few days.

Histological Changes.—Halliburton gives the following excellent account of these changes:—"The alveoli of the glands during the secreting periods are found to be lined with very short columnar cells, with nuclei situated towards the centre. The edges of the cells towards the lumen may be irregular or jagged, and the remainder of the alveolus is filled up with the materials of the milk. During the intervals between the acts of discharge, the cells of the alveoli elongate towards the lumen, their nuclei divide, and in the part of the cells towards the lumen a collection of oil-globules and of other materials takes place. The next stage is that the cells divide, and the part of each towards the lumen containing a nucleus and the materials of the secretion disintegrates and goes to form the solid part of the milk. The cells also secrete water, salts, and milk-sugar. The fat, etc., of the milk are not simply picked out from the blood by the secreting cells, but these materials are formed by metabolic processes within the protoplasm of the cells. In the earlier days of lactation, epithelial cells only partially transformed are discharged in the secretion; these are termed "colostrum corpuscles."

7. *The Lochia.*—With the expulsion of the placenta a large raw surface is left at one part of the inner surface of the uterus, whilst a minor degree of denudation occurs over all the rest of this surface, owing to the detachment of the chorion. From the whole of this denuded area a discharge of blood and serum takes place; this discharge, mingled with shreddy fragments of decidua, and modified by the admixture of cervical and vaginal secretions, constitutes the lochia. The proportion of blood is greater than is found in the discharges from raw surfaces elsewhere, because the uterine vessels are not so perfectly secured as are those in an ordinary operation wound. In pre-antiseptic times the discharge usually became purulent after a few days, just as the formation of "laudable pus" was regarded as a normal stage in the healing of a wound; and consequently the lochia were distinguished, according to their character, as rubra, serosa, and alba. The total quantity of the discharges after labour was naturally greater when suppuration took place; and we accordingly find that the quantities which were formerly considered normal were greatly in excess of those met with at the present day. Gassner gave the following as the result of his researches:—

Lochia rubra, 1-3 day . . .	1000 grms.
Lochia serosa, 4-5 day . . .	280 „
Lochia alba, 6-8 day	205 „

Hence a woman after labour loses in 8 days 1485 grms. = 52·29 oz.
A nursing woman loses in all only 1085 grms. = 38·2 oz.
Whilst a woman not nursing loses 1880 „ = 66·19 oz.

The majority of subsequent writers have quoted these figures, which, however, for the reasons given above, are not applicable to confinements conducted according to modern methods. Moreover, Gassner's observations were made on two cases only, one being a suckling and the other a non-suckling woman. In order to determine the question of the normal amount of the lochia, I carried out an investigation on 64 consecutive cases at the General Lying-in Hospital, Lambeth. The method of procedure was as follows:—

The lochia were received in wood-wool pads covered with sublimate gauze. These pads were made carefully to scale in two sizes, 1 oz. and $\frac{1}{2}$ oz. respectively; the former being employed at first in each case, and replaced by the smaller ones as the discharge diminished.

After removal, each pad was at once again weighed, the difference representing the amount of discharge during the time that the pad was on.

When, two or three times in succession, the soiled pad was found not to have gained in weight, the lochia were regarded as having ceased.

Four of the cases were not normal, and were not included in my calculations. The remaining 60 cases gave the following results:—

The lowest quantity was 2 oz., the highest 24 oz.

In 30 cases, or 50 per cent, the quantity was 10 oz. or less.

In 19 cases, or 32 per cent, the quantity was 10-15 oz.

In 8 cases, or 13 per cent, the quantity was 15-20 oz.

In 3 cases, or 5 per cent, the quantity was over 20 oz.

The average quantity, taking the whole of the 60 cases together, is 10·89 oz. If we exclude 3 cases above 20 oz., the average, calculated on 95 per cent, is 10·2 oz. Hence we conclude that the average normal quantity of lochia is about $10\frac{1}{2}$ oz.

The duration of the discharge was from five days to a fortnight, and was distributed as follows:—

In 4 cases . .	5 days	In 6 cases . .	10 days
In 4 „ . .	6 „	In 7 „ . .	11 „
In 10 „ . .	7 „	In 6 „ . .	12 „
In 11 „ . .	8 „	In 1 „ . .	14 „
In 11 „ . .	9 „		

That is, in 40 cases, or 66 per cent, it was nine days or under. The average on all the cases is 9·75 days.

A practical deduction is that it is usually safe for the patient to get up on the tenth day.

As to the factors which may influence the quantity of the lochia, the chief interest, in view of Gassner's results, lies in the question of suckling. On this point my cases do not bear out Gassner's conclusion that the quantity is considerably increased in non-suckling women.

In 53 cases in which the patient nursed the baby the average was 11·2 oz.; in 7 cases in which the child died, or was fed by hand, the average was 10·3 oz. The number in the latter class is small, as only two were still-born, and among the others weaning was not encouraged. But though the number is too small for much stress to be laid on the figures, it is at least clear that non-suckling does not increase the quantity of lochia.

The age and parity of the patient were found to bear no relationship to the amount of the lochia. On the other hand, the quantity was found to vary directly with the weight of the child, and especially with that of the placenta; with the amount of blood lost at the time of labour, and with the habitual amount of the menstrual flow; whilst the quantity was also greater in the case of dark colouring and complexion than with fair women.

B. *Changes in the Pelvic Organs—Involution.*—1. *The Uterus.*—The changes in the uterus constitute by far the largest and most important feature of the process of involution. For whereas we have to study, in the abdominal wall, the recovery from distension; in the uterine appendages, broad ligaments and bladder, the return from mechanical displacement; in the vagina, vulva and perineum, the recovery from violence during labour; we have to follow, in the case of the uterus, the extraordinary and rapid changes by which an organ weighing 2 to 3 lbs. is transformed, within six or eight weeks, into one weighing 1 to 2 ounces. The process is rapid enough to be readily traced at the bedside, and we shall take this aspect of the subject first; after which will be considered the anatomical changes on which the clinical phenomena are based. Lastly, we shall have to inquire how far the way in which involution is effected is explained by histological and chemical data.

(*a*) *Clinical Features.*—At the conclusion of the third stage of labour the uterus can be felt, under normal conditions, firmly contracted, and lying in the hypogastrium, reaching nearly up to the umbilicus. It has been aptly compared to a cricket-ball, in the impression it conveys to the hand. Contraction is not continuous, but rhythmical; but in the intervals of relaxation it should remain retracted, and it is found in this condition except when hæmorrhage is going on or when distended with clots. On palpating the uterus during the phase of retraction with relaxation, it feels rather soft and ill-defined, and its upper border usually reaches a slightly higher level than during contraction. With the progress of involution the uterus gradually recedes from the abdomen, and when the process is complete it has resumed its normal non-parous position of an entirely pelvic organ. By noting the position of the uterus on the successive days of the puerperium we can obtain a valuable clinical indication of the progress of involution, or, on the other hand, of its disturbance and interruption by pathological conditions, of which we thus receive an early warning.

The estimation of the uterine recession has been attempted in various ways. Hecker, Buhl, and Scanzoni measured the uterus of women who died at different times after delivery. Serdukoff collected from the tables of these authors the cases where death did not apparently arise from disease of the sexual organs, and where, consequently, involution was almost normal; and he thus got 23 cases, including 2 of his own. But he concluded that no reliable data could be derived from such a small number. Serdukoff also attempted to gauge the uterine measurements by the introduction of the sound; but he concluded, as other writers have done, that this plan, besides being not devoid of risk, was also unreliable in its results. Sinclair adopted the sound for measuring the uterine cavity at various intervals after delivery; but as only one observation was made on each of his 324 cases, his results are of little value for the present purpose.

Wieland was the first to adopt the plan of external measurements of the length and breadth of the uterus. He concluded that up to the seventh day there was a daily diminution in length of from 1 to $1\frac{1}{2}$ cm., and after that of $\frac{1}{2}$ to 1 cm. At the tenth day he described the uterus as being out of reach of measurement, having receded behind the symphysis. Schneider carried out some observations by a similar method. Serdukoff undertook a careful investigation, with special precautions to exclude sources of error; he concluded that the transverse measurements gave a more reliable indication of involution than the vertical ones. We shall have to refer later on to his *résumé* of the circumstances by which involution is affected.

The best recent work is that of Stevens and Griffith. They advocate vertical measurements, because the transverse measurement is difficult to take, and not practicable with any degree of accuracy after the first four days, unless the uterus remains abnormally large. To obviate fallacies, the measurement must be taken at nearly the same hour daily; the bladder and rectum must be empty, and the uterus must be in the normal mesial position and anteverted, and must be measured in a state of contraction. The character of the pelvis must also be borne in mind: in a flattened pelvis the uterus will be found considerably higher than in a kyphotic pelvis (Barbour). Stevens and Griffith suggest a convenient way of recording the variations in the height of the fundus, by the use of the ordinary temperature chart; the 100° F. line of the chart is taken to represent the pubes, and the lines above, 101°, 102°, etc., represent in inches the height of the fundus above the pubes.

The height of the fundus on successive days is here given according to Stevens and Griffith (the figures representing approximately the mean of the morning and evening records) and Luisstag.

	Stevens and Griffith.	Luisstag.
1st day . . .	$5\frac{1}{4}$ inches	6 inches
2nd „ . . .	5 „	$4\frac{4}{5}$-$5\frac{1}{5}$ „
3rd „ . . .	$4\frac{2}{3}$ „	$4\frac{2}{5}$ „
4th „ . . .	$4\frac{1}{3}$ „	4 „
5th „ . . .	4 „	$3\frac{3}{5}$ „
6th „ . . .	$3\frac{1}{2}$ „	$3\frac{2}{5}$ „
7th „ . . .	$3\frac{1}{3}$ „	$3\frac{1}{5}$ „
8th „ . . .	$3\frac{1}{6}$ „	$2\frac{4}{5}$ „
9th „ . . .	$2\frac{5}{6}$ „	$2\frac{3}{5}$ „
10th „ . . .	$2\frac{3}{4}$ „	$2\frac{2}{5}$ „
11th „ . . .	$2\frac{1}{3}$ „	$2\frac{1}{5}$ „
12th „ . . .	$2\frac{1}{6}$ „	2 or under.

Varnier thinks that Luisstag's figures are too high, and says that he has often found the height of the fundus less than 5 inches in the second half of the first day; 4 inches on the second day; $2\frac{2}{5}$ to $3\frac{1}{5}$ at the fifth to seventh day; and lying behind the pubes towards the ninth day.

The height of the fundus is increased by

(1) Distension of bladder, rectum, or intestines.

(2) Mechanical distension of the uterus by clots, retained placenta, or membranes.

(3) Sub-involution.

(4) Anatomical peculiarities, such as abnormal high position of the uterus or unusual thickness of its walls.

The height of the fundus is diminished by malposition of the uterus—namely, prolapse, retroversion, extreme anteflexion, and excessive lateral obliquity.

In cases in which there is a doubt as to whether the enlargement of the uterus, as indicated by the height above the symphysis, is apparent or real, the external measurement should be checked by a bimanual examination, which, though of little value as a precise measurement, will give a fairly accurate indication as to increase in size.

(*b*) *Anatomical Features.*—Our knowledge of the anatomy of the uterus during the puerperium is mainly based on observations of frozen sections made by the following authorities:—

1. Stratz (1886), I-para, 1 hour after delivery. 2. Barbour and Webster (1891), multipara, immediately after delivery. 3. Barbour (1888), I-para, $1\frac{1}{2}$ hours after delivery. 4. Webster (1892), multipara, 2nd day after delivery. 5. Webster (1892),

multipara, 3rd day after delivery. 6. Varnier (1900), (?), 3rd day after delivery. 7. Varnier (1900), (?), 3rd day after delivery. 8. Webster (1892), multipara, $4\frac{1}{2}$ days after delivery. 9. Barbour (1888), I-para, $5\frac{1}{2}$ days after delivery. 10. Webster (1892), multipara, 6 days after delivery. 11. Webster (1892), multipara, 15 days after delivery.

The following description is based on the work of these authors.

i. *Macroscopical Characters.*—Immediately after delivery the uterus consists of a firmer thick-walled upper portion and a lower flaccid thin-walled portion. The transition between the two portions is sharply defined on the anterior wall, but more gradual on the posterior wall. The line of union of the upper and lower portions represents a retraction ring, which is not that of labour, but is nearer the cervix, part of the lower segment having been taken up into it. The cervix is thick, flattened vertically, and partly everted; the os internum cannot be defined, even microscopically. The whole organ measures about 8 inches in length and $3\frac{1}{2}$ inches antero-posteriorly; the cavity measures 7 inches. The weight is about $3\frac{1}{4}$ lbs. (Varnier). The softness of the lower segment causes it to lie in a somewhat crumpled-up condition; the whole uterus is anteverted, but not anteflexed. The thickness of the walls of the upper segment is about $1\frac{1}{2}$ inches anteriorly and posteriorly, and about 1 inch at the fundus; in the flaccid portion the anterior wall is about $\frac{1}{2}$ an inch and the posterior $\frac{3}{4}$ of an inch in thickness. The peritoneum has a firm attachment on the posterior aspect of the uterus; but anteriorly it can be stripped up to a "line of firm attachment," which has a position varying from 2 to 4·8 inches above the anterior lip (Barbour).

When the uterus is laid open it presents a pear-shaped inner surface, which consists above of an oval area 7 inches transversely and $5\frac{1}{2}$ inches from above down. This passes below into a band 4 inches wide and 2 inches vertically. The band is the opened-out cervix; it is of a bluish-red colour (due to ecchymoses) and comparatively smooth, save for the branches and stem of the arbor vitæ. The oval upper area consists of two parts—a ragged and dark purple patch, about one-sixth of the whole in size, surrounded by a brick-red surface mottled with numerous tags. The former is the placental site, the latter the decidua-covered part of the uterus (Barbour).

The uterus is still abdominal on the fourth day, and on the sixth is just within the brim at the conjugate. The vertical measurements are thus summarised:—

Cases.	Cervix.	Body.	Whole Uterus.	Cavity.
2nd day	$2\frac{1}{8}$ inch	$4\frac{7}{8}$ inch	$7\frac{1}{8}$ inch	$6\frac{1}{8}$ inch
3rd "	2 "	$4\frac{3}{8}$ "	$6\frac{3}{8}$ "	$5\frac{5}{8}$ "
4th "	2 "	$5\frac{1}{8}$ "	$7\frac{1}{8}$ "	$6\frac{1}{4}$ "
6th "	$1\frac{5}{8}$ "	$3\frac{1}{2}$ "	$5\frac{1}{8}$ "	$4\frac{5}{8}$ "
15th "	$1\frac{1}{4}$ "	$2\frac{1}{2}$ "	$3\frac{3}{4}$ "	$3\frac{3}{8}$ "

There is but little diminution in size for the first four days. On section there is the appearance of contracted and anæmic non-striped muscle, without any naked-eye appearance of fatty degeneration. The post-partum uterus acts as a plug in the pelvis. The ovarian and uterine arteries are twisted and compressed by the uterus against the pelvic wall, the uterus, with the exception of the cervix, being anæmic. The cervix is congested and will bleed easily; post-partum hæmorrhage from the torn cervix is most marked where the pelvis is large (because the uterus does not plug so efficiently), or contracted (because the uterus cannot sink down).

The cervix, which at the end of labour is soft and limp, and which passes insensibly into the body of the uterus, gradually resumes its normal characteristics within the first fourteen days; by this time the arbor vitæ shows its characteristic folds, the canal has narrowed, and the internal os is readily distinguished. By the twenty-first day the canal has contracted to the normal calibre, and the internal os is sharply defined. At the end of the sixth week the cervix is quite normal.

ii. *Microscopical Characters.*—Wm. Hunter taught that the post-partum uterus is lined by a "stratum" of decidual membrane; Cruveilhier and Heschl, in later times, held the view that the uterus was laid bare down to the muscle. Matthews Duncan supported Hunter's view, which has been confirmed by the work of Friedländer, Kundrat and Engelmann, Langhans, Leopold, Küstner, Turner, and others. This stratum is about 2 mm. in thickness, and consists of uterine glands imbedded in interglandular tissue. The glands are lined, at their deeper part, by a cubical epithelium; in the middle portion, where the dilatation of the glands gives the appearance which has led to the designation of "the spongy layer," the epithelium is often wanting. In many cases the line of cleavage in the separation of the membranes appears to have passed through this layer; but in other cases a more superficial and compact portion of the glands remains, and here the epithelium is again found, of a columnar type. A surface epithelium also is sometimes present. In the portion of the decidual area nearest the cervix the mucosa is generally found in a more complete form than in the area nearer the placental site.

The mode of involution of the uterine muscle was also formerly a disputed point. Kilian (1849), who believed that the hypertrophy of the uterus during pregnancy was due both to enlargement of existing muscle fibres and to the new formation of others, held that both kinds of muscle-fibre disappeared completely by a process of fatty degeneration. Heschl supported this view of involution, saying that, of the uterus which existed before labour, not a fibre survived. Kölliker also attributed involution to fatty degeneration, but thought that most of the muscle-fibres remained, though they diminished in length and thickness. Robin (1848-1861) held a quite different view, maintaining that the process was one of simple atrophy without fatty degeneration, and that none of the muscle-fibres disappeared. Meola (1885) attributed the regression of the muscle-fibres to a process of cirrhosis due to a rapid proliferation of the intra-muscular fibrous tissue. Sänger (1888) denied the proliferation of the connective tissue, but supported the doctrine of fatty degeneration, without, however, any disappearance of muscular fibres. Mayor's (1888) explanation was very similar to Sänger's. Helme (1889), in a careful investigation, revised the question, and his conclusions are now accepted as final. He finds that involution "does not bring about a destruction of the cells. It is merely a transition from larger to smaller dimensions. . . . It is an incomplete atrophy—not a numerical, but a simple physiological atrophy; the process in each fibre goes on to a certain point and then stops—the fibre remains, only it is of smaller volume." As to the way in which this is brought about, Helme finds no evidence whatever of fatty degeneration; neither is there any increase of connective tissue. "The change is one of physiological retrogression; the actual chemical character is not revealed by the microscope, but it is probable that the cell-protoplasm undergoes a sort of peptonisation—all the surplus material that is no longer required being changed into some more soluble substance, which finds its way into the surrounding lymph." Helme's explanation of the process receives some support from Fischel's researches, according to which peptonuria is a constant feature of the puerperium, whilst peptone is also found in the lochia and in the uterine muscle. Helme found that there was a gradual and progressive diminution in amount and disappearance of the connective tissue. Some of the connective tissue fibres during the first three days swell up and become hyaline, eventually breaking down into granules. The connective tissue cells also become more and more granular, and their nuclei are greatly changed, breaking up into fragments. In some places the destruction is so complete that all traces of connective tissue fibres are lost, their place being taken by a clear matrix containing a mass of entangling granules and degenerating leucocytes, and corpuscles and nuclei. Scattered through this are the large plasmodia, which begin to be formed in the later days of pregnancy, and whose function is evidently to eat up the waste material lying around them. At the same time, large granular epithelioid cells are found, with a single clear vesicular nucleus; on the sixth day they are found to be almost filled with bright yellow granules derived from the disintegrating red blood-corpuscles.

In both arteries and veins there is observed in the smaller vessels a process, first of compression, then of obliteration; whilst many of the larger vessels exhibit a proliferation of the intima, which results in a complete blocking of the lumen, and the conversion of the vessel into a fibrous cord which ultimately disappears. The plasmodia are especially congregated round the vessels, and no doubt they assist in absorbing the contents of the cells of the vessels which are undergoing the gradual diminution.

2. *The Uterine Appendages and Broad Ligaments.*—The outer or pelvic extremity of the broad ligaments and Fallopian tubes being relatively fixed, it follows that, as the uterus enlarges during pregnancy and rises in the abdomen, the tubes come to lie more or less parallel to the vertical axis of the uterus; and this is also the position in which they are found during the early part of the puerperium. The greater proximity to the uterus which results, and in which the ovaries take part, is further accentuated by

the lateral expansion of the lower part of the uterus, which encroaches on the cellular tissue of the lower part of the broad ligaments and separates their anterior and posterior surfaces. The ovarian ligaments become temporarily obliterated, being lost on the lateral surface of the uterus. As the uterus becomes progressively smaller, the layers of each broad ligament fall together, and the Fallopian tube and ovary become carried away from the side of the uterus, till, when involution is completed, the former resumes its transverse direction. The tubes are generally lengthened as well as drawn up during the pregnancy, and the same remark of course applies to the upper border of the broad ligament. If the involution of these structures does not keep pace with that of the uterus, the tube and ligament come to lie rather slack, with the result that the ovaries and tubes easily become prolapsed into the pouch of Douglas. The elongated round ligaments of the uterus also shorten during the puerperium; if they fail to do so rapidly enough, or to a sufficient degree, there is a great predisposition to backward displacement of the uterus.

3. *The Vagina.*—The vaginal walls, enlarged both in width and in length, remain lax and flaccid at first, but the sigmoid shape of the vaginal canal may be restored in three days (Webster). The anterior and posterior walls of the vagina fall into apposition almost at once in their upper portion; the lower portion, however, gapes. The posterior wall, being relatively fixed in its upper portion, is generally but little disturbed, except from such laceration as may have occurred in its lower part, and by efficient repair of perineal tears all bad results are avoided. But with the anterior wall it is otherwise. The attachment to the back of the pubes through the medium of the base of the bladder is generally so far loosened that there is nearly always a tendency to some prolapse in the form of cystocele, and this may persist, especially when labours succeed each other rapidly.

The pelvic-floor projection is increased for the first few days. Thus Webster found the measurements in his cases to be as follows:—First day, 2 in.; second, $1\frac{7}{8}$ in.; third, $1\frac{5}{8}$ in.; fourth, $2\frac{1}{8}$ in.; sixth, $1\frac{1}{2}$ in.; and on the fifteenth day, 1 in.

4. *The Bladder.*—After delivery the bladder resumes its normal shape, and when empty it lies below the level of the symphysis pubis. Halliday Croom stated that the bladder may be higher after delivery than it was before. Webster, however, from the study of his frozen sections, considers that this view is wrong, and that the bladder is never higher, but may be lower during the lying-in. After severe or repeated labours the base of the bladder is partially loosened from its pubic attachments, and may bulge down and backwards, in conjunction with the anterior vaginal wall.

A considerable measure of the interest which centres round the puerperal bladder is derived from the influence which a full bladder exerts on the height and position of the uterus. The question has been studied in great detail by Croom. According to him, distension of the bladder pushes the uterus up higher and away from the abdominal wall, and also causes some deviation to one side or other. It has been generally taught that this deviation is to the right, but Croom considers that left lateral deviation is more common. The main reason for this is that, as the bladder fills, it generally expands to the right. When the uterine deviation is to the right, he regards it as due to a previous right deviation during pregnancy, to loading of the rectum, or to accidents of position. There is usually some asymmetry of the bladder, even in the non-puerperal condition. According to Barkow, of 35 bladders in the adult female, 4 were symmetrical; there was a minor degree of asymmetry in 10, major in 21. The deviation was to the right in 18 cases, to the left in 8. In those cases where there is rotation of the uterus on its longitudinal axis, the rotation is emphasised by a full bladder. Croom found that there was rotation in 10 out of 40 cases examined. This corresponds with the observation of Börner, who found that out of 64 cases there was no rotation in 50; rotation to the right in 12, and to the left in 2. Haig Ferguson believed that there might be sufficient rotation to bring the left ovary so far forward as to be grasped in the Credé manipulation. According to Webster, the rotation of the uterus is insufficient to bring its transverse diameter into the right oblique diameter of the pelvis, and the ovaries do not take up positions corresponding to the rotation. As to the amount of urine which suffices to cause upward and lateral displacement of the uterus, Pfannkuch says that 100 cc. (3·5 oz.) of urine raise the uterus about 1 cm. (⅖ in.). Autefage states that 400-600 grammes (14 to 21 oz.) of urine will cause an increase in the real height of the uterus, which is not less than 4 to 9 cm. (1½ to 3½ in.). Croom attributes these results to observations being made at varying periods of the puerperium. He finds that in the early puerperium the uterus is not displaced appreciably till the bladder contains 20 to 30 oz. of urine.

5. *The Abdominal Walls.*—After the great distension produced by the pregnant uterus, the abdominal walls after delivery lie flaccid and loose, appearing to be too large for the abdominal contents, and the skin is wrinkled. For some weeks the muscles are lacking in tonicity, and, owing to their elongation, they cannot contract efficiently. To this cause among others may be traced the paresis of the vaso-motor system, of the bowels, and of the bladder. In some cases, and especially after rapidly succeeding pregnancies, the common tendon of the internal oblique and transversalis is so stretched that the two recti remain separated, and when the patient strains the abdominal contents bulge between them, causing a ventral hernia in the form of a long, low vertical ridge. When the recti and the lateral abdominal muscles alike fail to regain their tone a pendulous belly results, which is not only inconvenient and ungraceful at ordinary times, but may result in considerable inconvenience during subsequent pregnancies, leading to malpresentations and to inertia during labour.

6. *Evidences of recent Delivery.*—The diagnosis of recent delivery has sometimes a medico-legal importance, and it may depend on anatomical or on clinical signs. Anatomically, the condition of the uterus is of chief importance. It is not necessary to recapitulate what has already been said on this point.

Clinically, evidence is derived from the condition of the abdomen, breasts, and genital tract. On examining the abdomen its walls are loose and ill-fitting, and traversed by striæ of a more or less vivid red. It is assumed that the rapid emptying of the abdomen due to other causes, such as the evacuation of fluids or the removal of tumours, can be excluded, for in this manner also the lax condition of the abdominal walls could be accounted for. The striæ, however, are seldom so well marked or so red in other conditions as they are in the puerperium; and moreover, there is usually a marked pigmentation of the linea alba after labour. On palpation of the abdomen, the enlarged uterus can be felt occupying the pelvis. Further examination will be required to distinguish this from other kinds of tumour. The breasts are enlarged and tense, and present a large dark areola. Milk is freely secreted. The condition of the breasts gives but little indication as to the date of the delivery, except that, if the secretion consists of colostrum, labour must have occurred only one or two days previously.

On examination of the genital tract, lochia are found flowing from the vagina. If they are mainly composed of blood, we have probably to do with the first ten days of the puerperium; later, the discharge is sero-sanguinolent, and, later still, serous. The vulva is found swollen, and appears rather bruised. Some laceration of the fourchette or perineum will usually be present. The vagina is lax, stretched, and may present some lacerations, whilst its lower portion gapes. The cervix is soft and thickened, and for the first day or two after labour its outlines may be difficult to define. The lips of the cervix present some recent lacerations or fissures, and the canal is patulous, especially in its lower portion, where for the first few days it readily admits one or two fingers. Bimanually, the uterus is felt to be enlarged and usually strongly anteverted. The date of delivery can be roughly estimated by the height of the fundus uteri above the symphysis pubis. If the case be watched for a week or ten days, the gradual diminution in size of the uterus is quite characteristic, as it can be simulated by no other condition.

II. The Management of the Puerperium

1. *First Duties.*—After the expulsion of the placenta the patient should be cleansed and made comfortable. The advisability of a vaginal douche as a matter of routine is the subject of some difference of opinion. In hospital practice we think that the douche should always be given, whilst in private practice it is sometimes better that it should be omitted. The indications for the employment or withholding of the douche may be broadly formulated as follows:—

The douche is indicated (*a*) in all cases of operative delivery, such as forceps, turning (by internal manipulations), and craniotomy; (*b*) in other cases where the hand has been introduced, as for the replacement of the funis, the bringing down of the arms in extension above the after-coming head, or the extraction of placenta or membranes; (*c*) in tedious or difficult labours, involving injury to cervix, vagina, or perineum; (*d*) when the fœtus is decomposed; (*e*) when purulent or muco-purulent discharges were present before labour; (*f*) when there is a tendency to post-partum hæmorrhage.

The douche may be withheld (*a*) when labour has throughout been spontaneous, and no vaginal examination has been made; (*b*) when a few examinations have been made in a normal case, and the uterus contracts well.

An intra-uterine douche should be given only when there has been intra-uterine manipulation, or when the uterus does not contract well.

After the cleansing a binder should be applied. It should consist of a material sufficiently soft to allow of its fitting closely; below, it should reach four inches below the trochanters, and above it should just come up to the front of the costal margin. The binder is supposed to fulfil three objects: first, to give the patient a sense of comfort; second, to counteract the diminished intra-abdominal pressure; third, to restore the patient's "figure." From measurements carried out on three series of patients, the first with the binder applied in the ordinary way, the second without binder, and the third with a binder applied and kept specially firm, Herman came to the conclusion that, considered as a means of keeping the waist small, a binder of the ordinary kind has not the slightest effect. Nor has a binder any effect in causing or maintaining uterine contraction. In the discussion on Herman's paper at the London Obstetrical Society, Champneys expressed the view that the absence of a binder favoured the production of the condition of pendulous belly, and that the use of a binder was to keep the abdominal walls in a favourable condition and position during the involution which they, in common with other structures hypertrophied during pregnancy, should undergo during the lying-in period.

When the patient has been made comfortable, the bed should be made, a draw-sheet being placed under her. The room should be darkened and left with a window open, and the patient should be encouraged to sleep. The accoucheur should not leave the house till the pulse has become lower than 100, this being a sign that there is no special tendency to hæmorrhage.

After a few hours the baby, which has meanwhile been washed and dressed, may be put to the breast for a few minutes. The nurse should be instructed to keep a careful watch for any symptoms of hæmorrhage, by looking at the pads and by feeling the abdomen from time to time, to ascertain that the uterus is contracted or retracted. At the first subsequent visit the obstetrician should, as a matter of routine, inquire about after-pains and the emptying of the bladder; the pulse and temperature should be noted, as well as the patient's general condition; he should see the pads and make special inquiries as to the passing of clots; and lastly, he should examine the abdomen, to ascertain the condition of the uterus and of the bladder. The latter will sometimes be found distended, even when the patient is alleged to have passed water.

After-pains are due to painful uterine contractions, and are usually most pronounced when the uterus has not become exhausted by a difficult or tedious labour; they are, therefore, more common in multiparæ than in primiparæ. They also become more severe when clots require to be expelled; and they may be induced reflexly by the application of the child to the breast, or directly by the application of the hand to the abdomen. When they occur in moderation they are rather a welcome sign than otherwise. But if they become excessive they are bad, both because they are disturbing to the patient, and also because they may then be due to some irritation of the uterus, or to a pathological condition within its cavity. When, therefore, after-pains are moderate, they require no treatment; but when they are severe they must be relieved, and they may also constitute an indication for intra-uterine interference. The latter is specially indicated if the uterus is found to be bulky, or lying too high in the abdomen. For the relief of after-pains, in most cases, nothing is so effectual as phenacetin: it may be given in a dose of 10 to 15 grains, repeated, if necessary, in one or two hours. In severer cases, chloral may be administered in doses of 20 to 30 grains. Opium and morphia should only be given as a last resource.

During the whole of the puerperium, the pulse and temperature should be regularly recorded; and it is a great advantage for the daily height of the fundus to be recorded at the same time, in the manner suggested by Stevens and Griffith. The chart will then constitute a record of progress which will be of special value, since any unfavourable indications can be detected at a glance.

2. *Cleanliness* is perhaps the most important individual factor in securing a favourable convalescence. The patient's body-linen and bed-linen should be kept scrupulously clean, and changed as often as necessary. The external genitals should be washed several times a day for the first few days, and the vulvar pads should be renewed every time. In normal cases daily douching is not necessary; it is quite sufficient that the outside parts be washed and carefully dried. Any offensiveness in the discharges should, however, be the signal for a vaginal douche; for this purpose, biniodide of mercury (1 in 3000), iodine (1 drachm of the tincture or liniment to the pint), sanitas (1 part to 5 of water), or chinosol (1 in 3000) may be used. An intra-uterine douche should not be given except by the medical attendant. The patient should be sponged daily with tepid water, from head to foot, and carefully dried; only a small part of the patient's body should be exposed at a time. The breasts require special attention, so that they may be kept clean, and free from milk becoming sour.

3. *Diet.*—Formerly a low diet was considered the proper one for the lying-in woman. So long ago as 1864, Graily Hewitt uttered a protest against this practice, urging that the diet should be a generous one, both

because the patient's strength required building up, and because she had to nourish the baby as well as herself. At the present time a rational treatment more largely prevails. For the first twenty-four hours the diet should consist of liquids, but it should be nourishing, and the "tea and toast" tenets should be relegated to the same limbo of defunct prescriptions as the "starve a fever" principle. In a normal case, if the patient is hungry at the conclusion of labour, she may have warm milk, soup, gruel, or cocoa. In other cases, she is better left undisturbed in every way till after her sleep, when the same kind of nourishment should be given. On the second day she may take such things as custards, soft-boiled eggs, corn-flour, milk-porridge, etc. From the third day onwards a light ordinary diet is indicated, including white fish, chicken, lamb or mutton, merging into the diet of daily life. For particular cases, certain modifications are necessary. Thus, after prolonged anæsthesia, no nourishment should be given till its effects have passed off; in fact the case must be treated as a post-operative one. If febrile symptoms develop, a liquid diet will have to be maintained for a longer time. If the patient does not nurse the baby, the diet will not require to be so full as when nursing. Stimulants are best avoided in ordinary cases. The popular superstition that stout has specific virtues in the formation of milk must go the way of all superstitions; the best drink for the lying-in woman to take with her meals is good milk.

4. *Regulation of the Bladder and Bowels.*—As has been already mentioned, there is a considerable tendency to retention of urine after labour. This may act injuriously on the bladder itself, and favours post-partum hæmorrhage by the tendency to uterine relaxation which it induces. The patient should therefore be encouraged to empty the bladder within eight or ten hours after delivery; and even if she micturates spontaneously, the doctor or nurse should ascertain, by abdominal palpation, that the bladder is really emptied. There is some divergence of opinion as to the advisability of using the catheter when the patient cannot pass water alone. Varnier considers that it does no harm for the patient to go for twenty-four hours, and that the risk of cystitis precludes the use of the catheter in all but exceptional cases. The opposite view, which I emphatically endorse, is that at the end of twelve hours, if fomentations or change of position have a negative result, the catheter should be passed. If a glass catheter be used, it can be boiled every time after use and kept perfectly clean, and there is then no risk at all of cystitis. When the perineum has been torn and sutured, it is better to pass the catheter from the first, and to continue its use for thirty-six hours, to avoid contamination of the wound. It is of the greatest possible importance that when the catheter is used, the vulva should be carefully cleansed with warm water before the introduction of the instrument, and that the catheter should be introduced in full view, without fumbling. It is courting disaster to employ the old plan of feeling under the clothes, sweeping the finger over anus and vagina to the urethral orifice, and then passing the catheter along a contaminated finger; and the inconsistency of passing a carefully sterilised catheter into a urethra whose orifice lies amid unhealthy discharges is an absurdity that needs no demonstration.

Evacuation of the Bowels.—If the bowels have been carefully regulated during the latter part of pregnancy, and the rectum emptied by an enema during the first stage of labour, the obstetric field will be clean during delivery, and the daily action of the bowels will probably continue with very little interruption during the puerperium, especially if a proper diet has been given from the first.

The old plan of leaving the bowels locked up till the third or fourth day is becoming superseded by the practice of securing an evacuation within the first thirty-six hours, if there is not a spontaneous action. Castor-oil is one of the most effective aperients; but besides its nauseous taste, it sometimes causes griping; and in general the patient may be given the aperient to which she is most accustomed; or a saline laxative such as citrate of magnesia may be administered, followed, if necessary, by a simple enema, or a glycerine injection or suppository. Thereafter a daily evacuation should be secured.

5. *Nursing and the Care of the Breasts.*—Every healthy woman should nurse her own baby, unless important reasons forbid it, both in her own interests and in those of the child; for lactation favours a healthy involution, and the child has always the best chance of thriving when brought up at the breast. Nursing is contra-indicated when the mother is the subject of chronic exhausting disease, especially tuberculosis; in the majority of acute diseases; when syphilis has been acquired late in pregnancy; when the supply of milk is insufficient; when the breasts are inflamed; in many cases when the nipples are under-developed, inverted, depressed, persistently sensitive or sore. In some cases of the latter class the use of a nipple shield will allow the continuance of the function with comfort to the mother and with advantage to the child.

The baby should be first put to the breast six to eight hours after labour, and then every four hours during the first few days. Regularity should be practised from the beginning; it is harmful to put the child to the breast every time it cries. Both breasts should be equally used. Sometimes, when the supply of milk is rather short, it is a good plan, when the baby is put to one breast, to place a receiver to the other; for the stimulation of one nipple usually causes reflexly a flow from both breasts at once, and the milk so collected can be kept warm and used to supplement what the child obtains by suckling. If, on the other hand, the breasts tend to become over-distended, some milk should be drawn off with the breast-pump; for when much distended, the nipple is relatively shortened; the child cannot get hold of it properly, and presses its nose against the breast, blocking the nostrils; it then has to let go the nipple in order to breathe. The frequent grasping and letting go discourages the child, produces soreness of the nipples, and leaves the breast insufficiently emptied. (See also "Affections of Breast and Nipples," p. 161).

6. *Examination of the Pelvic Organs.*—Inasmuch as many of the diseases of women are due to overlooked accidents occurring at the time of labour, and to unfavourable circumstances during the lying-in period, including too early a return to daily duties, it is important that an examination of the pelvic organs should be made before the patient is allowed to leave her bed. By the tenth or twelfth day in normal cases the vaginal outlet has nearly regained its normal dimensions, and there is no appreciable deficiency of the perineum. The lochia have practically ceased, although there may be a little return when the patient begins to sit up. The cervix is firm, its canal is contracted, and there are no deep lacerations. The uterus is movable, lies in a normal position, or is slightly "squatting" back, and is only a little above normal size, the sound entering for about 3 inches. The region of the broad ligaments is free of any effusion, and the ovaries and tubes can be felt, normal in size and position.

7. *Getting up and going out.*—It is advisable, in a normal case, that the patient should be allowed to occasionally sit propped up in bed at a fairly early stage of the puerperium, namely, from the fourth or fifth day; thus

she may be allowed to sit up a little for her meals. The change of posture favours uterine and vaginal drainage. If an examination shows that the pelvic organs are in the healthy condition described in the previous paragraph, the patient may be transferred to a couch as early as the tenth day; it is, however, an advantage for her to remain in bed for a full fortnight. Getting up must be postponed when the involution of the uterus is not satisfactory, when the lochia remain abundant, or when a torn perineum has failed to heal properly; whilst any effusion in the cellular tissue by the sides or in front of the uterus will necessitate a delay of some weeks. Undue laxity of the abdominal walls requires treatment at this early stage. Whatever the effect of the binder, a pendulous belly or a condition of wide separation of the recti is due to enfeebled abdominal muscles; and nothing has such a good effect, both immediate and remote, on these conditions, as the proper exercise of the muscles. After the first ten days the patient should be instructed to practise lying flat on her back, and raising herself into a sitting posture without using her hands and arms. This should be done for five or ten minutes at a time twice a day.

Once the patient has begun to get up, a return to the ordinary mode of life should be effected in easy stages. After a couple of days on a couch, she may sit up in an easy-chair, and begin to walk a little. A few days more, and she may go into another room, downstairs if necessary. Then a fine morning or afternoon is made the opportunity for a drive; and lastly, she may walk out at the end of the third week or the beginning of the fourth. In hospital practice patients often get up on the ninth day, and go home on the thirteenth or fourteenth; but this is usually a matter of necessity rather than of expediency; and when circumstances allow of it, a patient should be directed to lead the quiet life of a semi-invalid for six weeks after delivery, that is, till involution is anatomically complete.

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Pathological Section

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Definition.—A wound infection due to the action of micro-organisms, and originating in the generative organs of parturient women. It is not exactly synonymous with the terms puerperal septicæmia or puerperal fever, because it includes not only systemic infections, but also local inflammations.

Ætiology.—In considering the causation of this condition we may regard it from three aspects: (1) The micro-organisms which produce it, or the seeds of the disease; (2) The tissues involved, or the ground upon which the seeds are sown; (3) The ways in which the infective matter is brought to the patients, or the sowers of the seed.

The first of these has been fully dealt with under micro-organisms (vol. viii. p. 72), and it need here only be stated that in by far the greater number of cases streptococci are the cause both of the local affections and the general systemic disturbances; out of ninety-one cases examined by Czerniewski, Widal, and Bumm, they were present in eighty-five, or 94 per cent. The importance of other germs, either alone or in combination, in the production of puerperal infection has not been certainly determined, but there is little room to doubt that such infections have been due, in a certain number of cases, to colon bacilli, gonococci, bacillus pyocyaneus, bacillus fœtidus, the pneumococcus, diphtheria bacillus, and putrefactive saprophytes.

As regards the second, or the ground upon which the seed is sown, the condition of a pregnant or parturient woman is in many ways more favourable to the development of micro-organisms than at other times. She is in a state of plethora, hydræmia, hyperinosis, and leucocythemia. The total quantity of blood is increased, it is more watery, and contains more fibrin and a larger proportion of white cells, and is loaded with effete matter derived from the fœtus and the genital organs during their involution. The blood-vessels and lymphatics, especially in the genital organs and their immediate neighbourhood, are dilated and hypertrophied, and the nervous system is in a peculiarly irritable condition. The skin about the vulva is always infected with micro-organisms, often of a malignant kind, and the vagina also frequently swarms with microbes, some of which are indistinguishable microscopically from the most dangerous of their kind. The vaginal flora has attracted considerable attention. Dödirlein, for example, published the results of his investigations in 1892, from which he concluded that vaginal discharges might be classified as normal and pathological. The normal were met with in something over half the cases examined, and were characterised by a consistence of clotted cream, intensely acid reaction, and by containing a pure culture of an organism which he called the vaginal bacillus, and to which he attributed the production of the lactic acid to which the reaction was due. The pathological discharge was of thinner consistence, often puriform in appearance, sometimes containing bubbles of gas feebly acid, neutral, or even alkaline in reaction, and swarming with micro-organisms, some of which were dangerous. The normal discharges he discovered by experiment to be not only innocuous, but even antiseptic, and capable of destroying staphylococci and other germs introduced into the vagina. Kroenig, who repeated Döderlein's experiments, agreed with him as to the antiseptic properties of the normal discharge, but denied that it was due to the vaginal bacillus, and found that the so-called pathological discharges, which did not contain this organism, also possessed similar bactericidal properties. Menge attributed the germicidal powers of the vagina to: (1) the antagonism of the normal microbic flora to pathogenic organisms; (2) the products of the life process of vaginal bacilli; (3) the acidity of the discharge; (4) the germicidal powers of the anatomical elements of the vagina; (5) phagocytosis; and (6) the absence of free oxygen. Walthard found that the vagina often contained pathogenic microbes, but they were not virulent, and behaved as saprophytes, producing no results when inoculated upon healthy tissues, but becoming virulent when in contact with dead tissues or those whose vitality and powers of resistance had been reduced. From all these investigations we may conclude that the vagina contains germs which are harmless under normal conditions, but which may sometimes become dangerous in the presence of dead matter or tissue whose vitality has been reduced by crushing and bruising in prolonged and difficult labours, and may also be productive of harm if carried upwards into the uterus. The cavity of this organ and the tubes are usually aseptic, and the former is protected from invasion by the cervical operculum. This plug of mucus, though not in itself germicidal, furnishes no nutriment for micro-organisms, yet its lower part is often found to contain vaginal bacteria and leucocytes. The middle portion contains leucocytes only, and the upper neither leucocytes nor bacteria. It may therefore be described as consisting of septic, antiseptic, and aseptic zones. We see then that although the system of a pregnant woman is peculiarly favourable to the growth of septic organisms, yet nature has provided sufficient protection against their invasion under ordinary circumstances. During labour also nature is fully competent to avert evil; and the washing out of the vagina by the liquor amnii, and its further cleansing by the descent of the fœtus, and its afterbirth, tend in the same direction, whereas vaginal examinations, the introduction of instruments, and douches counteract these safeguards, and are liable to carry septic matter upwards. In concluding our remarks upon the seat of infection, we must not forget that open wounds or unprotected surfaces are always present in women who have recently been delivered, for not only are the vagina and the cervix frequently torn or abraded, but the interior of the uterus, from which the decidua has been separated, and especially the placental site, must be regarded as a wounded surface.

Thirdly, as regards the modes of infection. The micro-organisms, which we have seen are often present in the vagina before delivery, are a possible source of mischief, but whether they are ever the cause of puerperal infection has not yet been decided. Semmelweis taught that fever could originate in this way, and described it as auto-infection, and Ahlfeld thoroughly supports this view; but others, considering how infrequently women who are delivered without assistance are attacked by serious illness, deny the possibility of auto-infection. But I think the majority of those who have carefully weighed the evidence on both sides consider that such a mode of infection is certainly possible, though exceedingly rare, and that it might be due not only to the vaginal micro-organisms, but to those also which are occasionally present both in the uterus and the tubes.

In the vast majority of cases the infective material has been conveyed to the patient on the hands of her attendants, or on their instruments and clothing, or on materials used for cleansing purposes. The medical attendant may have been contaminated by suppurating or sloughing wounds, erysipelas, diphtheria, or dead and putrid matter, and the nurse may have handled septic or putrid discharges. Such hands would be peculiarly liable to propagate disease, but it must not be forgotten that dangerous material is everywhere, and that under all circumstances our hands are impregnated with germs, often of a most virulent nature. At one time the air was supposed to be the chief source of infection, but the results of antiseptic midwifery showed that this was not the case, and it then came to be regarded as of little importance. But this is equally erroneous, and there can be no doubt that many cases of putrefaction, if not of actual septicæmia, have been due to air vitiated by decomposing matter, and we cannot safely ignore the importance of a pure atmosphere in a lying-in chamber.

CLINICAL FEATURES

When infectious material has been introduced into the genital canal its further history depends upon whether the micro-organisms are able to penetrate the tissues or not. In the former case they are generally carried by the lymphatics and blood-vessels to distant parts—SEPTIC INFECTION; whereas in the latter they remain upon the surface, causing putrefaction, and the toxins thus formed cause putrid intoxication or SAPRÆMIA.

We may conveniently classify puerperal infections as follows:—

1. *Vulvitis and Vaginitis.*
2. *Endometritis.*
3. *Parametritis and Perimetritis.*
4. *Septicæmia.*
5. *Pyæmia.*
6. *Endocarditis.*
7. *Phlegmasia alba dolens.*

This classification is artificial, and in practice the various conditions occur in every possible variety of combinations, yet for descriptive purposes, and with regard to prognosis and treatment, it will be found useful.

Vulvitis, Vaginitis, and Endometritis may remain as purely local conditions, or they may be the first steps in a systemic infection. The chief points to be observed in determining this vital question are, the aspect of the patient; her subjective condition; whether she can or cannot sleep, and the rate and condition of her pulse. In general terms it may be said that if a patient looks and feels well she has not septicæmia.

The wounds in the vagina and about the vulva are peculiarly liable to infection, and readily assume the condition known as puerperal ulcers. These are attended by little or no fever, and the patient seldom complains; but ischuria or smarting when passing water is sometimes present. On inspection one labium is generally swollen, and upon examining its inner surface the ulcer is observed; its base covered with a white or greyish yellow slough, its margins red and swollen, and the discharge thin and irritating, causing excoriation of the surface over which it flows.

Endometritis may be either putrid or septic. In the putrid form the process may be general, or limited to certain areas, especially the placental site. The uterine wall rapidly proliferates a barrier of granulation tissue, which protects the deeper structures from invasion, and secures the separation of the diseased tissue. In septic infection this barrier is imperfect, or absent, and the micro-organisms invade the muscular tissue, the uterine wall becoming soft and swollen, and the disease spreads along the lymphatics to the cellular tissue and peritoneum.

Putrid endometritis is recognised by the character of the lochia, which may at first be scanty, but soon become profuse and offensive. The uterus feels large, and may be tender, and the after-pains are often abnormally acute. The attendant fever is seldom severe, the temperature seldom exceeding 102° F., or the pulse 110 beats per minute. The patient does not look dangerously ill, and her sleep is undisturbed.

Parametritis and Perimetritis.—These conditions are usually ushered in by a rigor, or at least a sense of chilliness on the second or third day after labour. In parametritis the temperature rises rapidly; in perimetritis more gradually, and the pulse follows the rise of temperature, the after-pains are exquisitely painful, and the uterus becomes tender; at first to one side, but subsequently the tenderness extends over the entire hypogastrium. The duration of the fever varies from days to weeks, but from eight to ten days is about the average.

Peritonitis and cellulitis are usually met with in combination, but it is of importance to determine which tissue is the more involved in a given case, and still more so to determine whether the condition is a local one, or part of a systemic infection.

In pelvic cellulitis the temperature rises rapidly, often to 104° F., the pulse following more slowly, reaches 100 or 110 beats on the following day; the constitutional disturbance is slight. On bimanual examination a swelling is felt to one side of the uterus, at first diffuse, but becoming harder and more defined; the uterus is pushed towards the opposite side of the pelvis, and as the swelling advances it involves and fixes the cervix; it extends outward to the pelvic walls and iliac fossæ, or backward along the folds of Douglas. Sometimes it extends along the anterior aspect of the broad ligament, to Poupart's ligament, and down the thigh along the femoral vessels. A localised parametritis usually ends in resolution, but suppuration may occur with hectic fever. In pelvic peritonitis the pain is much more acute and the constitutional disturbance greater. The temperature rises gradually, and seldom exceeds 102° F.; the pulse on the other hand rises rapidly, often reaching 120 or more beats per minute.

The effusion is less distinct, and is usually found behind or in front of the uterus. When Douglas's pouch is distended the vagina is pushed down before it, forming a well-defined dome, over which the mucous membrane can be easily moved by the finger; whereas in cellulitis this membrane is immovably fixed; the swelling may extend upwards, to, or above the fundus, and pushes the rectum to one side. In cellulitis, on the other hand, if posterior to the uterus, the swelling never extends above the line of firm peritoneal attachment; and sometimes completely surrounds the rectum.

It is of the utmost importance to decide whether these conditions are merely local inflammations or part of a general systemic poisoning. There is seldom any difficulty in deciding this question in the case of cellulitis, but it is otherwise in the case of peritonitis, and the most that we can do, for some days at least, is to hope that a localised peritonitis may remain so, and therefore the extension of tenderness to the upper part of the abdomen is an ominous symptom. On the other hand, a localised peritonitis is generally more acutely painful, and therefore intense hypogastric pain is relatively a good sign in these cases.

SEPTICÆMIA

A general infection always commences in one of the local conditions already described, most frequently as an endometritis, but the organisms invade the tissues, and are carried into the system by the lymphatics and blood-vessels, generally by the former alone. There is usually an incubation period of about thirty-six hours before the fever sets in, but since the infection may occur before, during, or after labour, the time when symptoms occur is also variable, but they do so most frequently on the third day after delivery. The fever is ushered in by a rigor or sense of chill, the temperature rises rapidly and remains high, with but slight remissions until shortly before death. The pulse rises rapidly, generally reaching 140 beats on the second day, and continues to increase until it becomes uncountable. The patient looks and feels extremely ill; her aspect is indeed almost pathognomonic of the disease. The face assumes a nervous, anxious expression, with pallor of the skin, which often assumes an icteric hue; the features become pinched, with hollow cheeks and sunken eyes. She is at first fretful and inclined to tears, with a dread of impending death; she cannot sleep day or night in spite of opiates. The lochia are scanty or suppressed, and in some cases putrid, the vulvar and vaginal wounds are covered with diphtheritic membranes. Peritonitis sets in early and soon becomes general, so that the abdomen becomes greatly distended and tender to the touch. As the disease advances a condition of euphorea sets in, and the patient may feel and say that she is well, though evidently most seriously ill. She often becomes drowsy or somnolent (septic somnolence), though when the disease involves the stomach she is constantly distressed by incessant vomiting, which continues without intermission to the end; the vomit at first consists of the stomach contents, but soon changes to green, brown (coffee ground), or black. The respiration becomes rapid and superficial. The surface is covered with a cold sweat, and the patient dies in collapse usually towards the end of the first or the beginning of the second week.

In the most acute forms of septicæmia the symptoms commence during or soon after labour, and death follows in a few hours. So rapid are some of these cases that there may be no rise of temperature, and but few post-mortem appearances.

Diagnosis is seldom difficult. The aspect of the patient, sleeplessness, her small and rapid pulse, and general peritonitis, are sufficiently characteristic; it has, however, often been mistaken for typhus or enteric fever, scarlatina, diphtheria, and acute tuberculosis.

Prognosis is generally bad, and the sooner the symptoms occur and the more rapid the extension of the peritonitis the worse it is.

Post-mortem Appearances.—The interior of the uterus and the vaginal and vulvar wounds are covered with sloughs, the uterine wall is swollen and œdematous, sometimes gangrenous. The lymphatics are plugged with thrombi, and on section look greyish-yellow, resembling minute abscesses. Cellulitis is almost always present, the tissue is œdematous, seldom infiltrated with pus, and microscopically shows a small-celled infiltration. This cellulitis is one of the most important lesions in the disease, as peritonitis is the result of the underlying cellulitis, and the general infection spreads along the cellular tissue with amazing rapidity, following the course of the lymph current, first along the ovarian and uterine vessels to the iliac fossæ, upwards to the diaphragm, and into the posterior mediastinum, causing pleuritis and endocarditis, or downwards under Poupart's ligament, giving rise to a phlegmasia alba dolens. The peritoneum is of a dark red colour, especially where it covers the intestines, and its cavity contains a thin, horribly fœtid or purulent fluid. Most of the important organs of the body are affected—the heart, pleura, kidneys, spleen, and liver. The skin is often icteric or covered with petechia or an erysipelatous blush.

PYÆMIA

Metrophlebitis would be a more correct term, because the inflammation spreads from the uterus to the veins, a phlebothrombosis being the essential characteristic, the formation of pus an accidental complication. The streptococci either invade the thrombi already existing in the mouths of the veins, or they first grow along the walls (periphlebitis) and then into them, causing inflammation of the intima, and thereby clotting and thrombosis. The thrombi thus infected break down and are carried as minute septic emboli through the vena cava to the heart and pulmonary system, causing infarctions. In pulmonary abscesses the micrococci themselves may pass through the pulmonary capillaries to the left side of the heart, and from thence be distributed throughout the body, causing abscesses in various parts. The process of thrombosis may extend widely, without the detachment of emboli, involving the pelvic, iliac, and femoral veins. Pyæmia commences as a rule much later in childbed than septicæmia. It has been observed to occur more frequently in cases in which there has been some anomaly in the third stage, either premature expulsion of the placenta by Crédé's method, or its retention and manual removal; also after placenta prævia. It is especially liable to supervene upon a septic endometritis or sloughing carcinoma. The endometritis may have been overlooked, and the practitioner be assured that the patient has been quite well until a violent rigor at once attracts attention. The patient looks very ill, with pinched features, chattering teeth, and shaking limbs. The temperature rises at once to 104°-105° F. or more, sweating sets in, followed by rapid defervescence to normal or below it, the patient feels relieved and looks well, and unless the condition is complicated by septicæmia (septico-pyæmia) there are none of the alarming symptoms of that condition present. The practitioner who arrives after the alarming symptoms have subsided should not be betrayed into giving too favourable an opinion upon finding the pulse and temperature normal and the condition of the patient good. A single rigor does not, of course, establish the diagnosis of pyæmia, and the disease, when present, may end in recovery after two or three rigors and without any localisation of pus; but usually the rigors return after an interval varying from hours to days, and abscesses appear in different parts of the body. They occur most frequently in the lungs, attended by pleuritic pains, with bloody or purulent expectoration; in the kidneys, causing lumbar pain, accompanied by the presence of albumin or blood in the urine; the spleen is generally enlarged. An abscess may form in the liver. The hepatitis may cause jaundice, but the yellow colour of the skin so frequently observed in these cases is most commonly due to the breaking down of the red blood cells. Not infrequently the joints are affected and become completely disorganised, or the sheaths of the tendons, especially those of the fore arm, suppurate. Subcutaneous abscesses occur much more frequently in puerperal than in surgical pyæmia, they form most often in the gluteal region, and as they are seldom associated with abscesses in the deeper organs, their occurrence is a favourable sign. The parotid gland, endocardium, and eye are less frequently attacked.

Course and Duration.—Sometimes the disease ends in recovery in a week or two, in others fatally, and the 16th to the 22nd day after delivery is the commonest term in such cases; in others rigors continue for a month or more, but such protracted cases generally recover.

Prognosis is always uncertain; about half the cases recover. The danger depends chiefly upon the importance of the organs affected, and those patients who are affected with subcutaneous abscesses recover as a rule.

Ulcerative Endocarditis

is a form of septicæmia, but as it is sometimes a primary localisation and presents a peculiar train of symptoms it requires separate consideration. It commences with fever, generally ushered in by a rigor, the temperature rises rapidly, and reaches its maximum on the second or third day; it remains high throughout with moderate remissions, and attended by repeated rigors. The pulse varies from 140 to 160, and is weak and dicrotous. The nervous symptoms are especially prominent: sleeplessness, headache, giddiness, delirium, apathy, and great prostration. There is delirium usually of a low muttering form, though occasionally of a wildly maniacal character, and the patient sinks into stupor and coma. The neck is retracted with convulsive twitchings, strabismus, grinding of the teeth, and paralysis; a common symptom is persistent diarrhœa. The ophthalmoscope reveals retinal hæmorrhages. Cardiac murmurs are usually absent, but even if detected do not assist the diagnosis, since such murmurs are common in lying-in women; it depends upon the general and especially upon the nervous symptoms, the repeated rigors and the retinal hæmorrhages. Ulcerative endocarditis differs from ordinary septicæmia in the absence of peritonitis, the early cerebral symptoms, and the longer duration of the disease; from pyæmia in the continued fever without intermissions and the absence of local pus formations. It resembles enteric fever in the constant diarrhœa and splenic enlargement, but differs from it in the course of the fever, the character of the stools, and the negative result of Vidal's test.

Pathological Anatomy.—The left heart is most affected; there are deposits on the mitral and occasionally upon the aortic valves. The myocardium is full of small abscesses, and the endocardium is infected with colonies of bacteria; the endocardium and valves are frequently ulcerated. A number of minute abscesses are found in the kidneys, and there is often suppurative meningitis and abscesses in the brain.

The Prognosis is absolutely bad.

Phlegmasia alba dolens, white leg or milk leg. There are two distinct varieties of this condition. In one a cellulitis extends down the thigh, in the other there is thrombosis of the veins with consequent œdema, but many authorities limit the term phlegmasia alba dolens to the cellulitic variety.

Symptoms.—Usually during the second week the patient complains of pain in the affected leg followed by swelling. In the phlebothrombotic form the pain and tenderness are confined to the course of the veins, and the swelling commences in the foot and spreads upwards; in the cellulitic variety the swelling commences in the thigh and extends downwards. The condition is attended in all septic cases by fever and constitutional disturbance, foul tongue, loss of appetite, vomiting, and restlessness.

Prognosis is fairly good in most cases; a compensatory circulation is established, but this is sometimes imperfect, so that the limb remains permanently enlarged. In some cases abscess forms and may lead to pyæmia; or a portion of clot may be displaced, carried to the heart, and obstruct the pulmonary artery.

Prophylaxis and Treatment.—The former of these is by far the more important. Authorities are generally agreed as to its main features, and differ only on minor details, whereas in treatment there is hardly a point upon which all authorities agree. The years 1870 and 1880 mark two important eras in the prophylaxis of puerperal infection. In the former year the antiseptic method was generally employed. The patient was regarded as more or less an infected individual, and efforts were made to purify her by douching, and various other antiseptic measures. But about 1880 this view was changed, and it became generally recognised that, in the vast majority of cases at least, there was no infective matter to be removed, and that all our efforts should be directed towards preventing its entrance; this is now known as the aseptic method.

There is no doubt that septic infection is most frequently carried to the patient by her attendants, and especially by their hands. This was taught by Semmelweis and Sir James Simpson; and Leopold has clearly proved that patients who have delivered themselves without any vaginal interference, make better recoveries than those who have been examined, even with the most scrupulous antiseptic precautions. We should therefore (1) confine local interference within the narrowest bounds; (2) avoid as far as possible septic contamination; (3) spare no pains to render our hands as innoxious as possible. The attendants should be most careful of their hands; and should a practitioner be called upon to attend patients with infectious diseases, or septic and putrid discharges, he should be careful as far as possible to avoid contamination; and much may be done in this way by using forceps or rubber film gloves. The nurse who has to wash away putrid lochia or foul discharges should be instructed how to do so without soiling her fingers.

Asepsis is, however, best maintained by substituting, as far as possible, external for internal manipulations. In 1888 Credé wrote as follows: "Even the simplest manipulations may cause infection. It should therefore be laid down and taught as a fundamental principle, that internal examination of parturient women should be altogether avoided, or restricted within the narrowest possible limits; it can be very well replaced by external examination. To instruct their pupils as thoroughly as possible in this method is the present and future duty of teaching institutions." Internal examinations are, however, occasionally necessary, but the practitioner should remember that such examinations are never altogether devoid of risk, and before resorting to them he should be fully persuaded in his own mind as to the necessity, and he should spare no pains to render his hands as aseptic as possible. This he does in two ways: firstly, by mechanically cleansing the skin with soap, hot water, and a nail brush; and, secondly, by using some chemical substance to destroy, or at least limit the procreative powers of the micro-organisms in the skin. Of the latter agents alcohol is probably the best, and next to it bichloride or biniodide of mercury. Carbolic acid, chinosol, creolin, and lysol are much employed, but are inferior to the former in bactericidal power. An antiseptic for use in ordinary midwifery practice must not only be efficient, it must also be portable, easily prepared, and not too costly; and all these requirements are fulfilled by corrosive sublimate, which is easily carried in tabloid form. Besides their hands, the attendants should observe the strictest cleanliness in their persons and clothing. With regard to the former, not only are the ordinary rules of cleanliness to be observed, but an individual who is suffering from a purulent nasal, oral, or other discharge, or carious teeth, should not attend women in their confinements. As regards clothing, most nurses now wear clean dresses and aprons fresh from the laundry. But it is not easy for a busy practitioner to provide garments of similar materials; he can, however, remove his coat, turn up his shirt-sleeves, and pin a clean towel in front so as to act as an apron.

The lying-in chamber should be clean and well ventilated, and should not be in close proximity to a watercloset or drain-pipe. The nurse should see that everything likely to be required has been provided, and that they are absolutely clean; to this end she should scrub thoroughly all basins, jugs, bed-pans, and other utensils, and she should provide an ample supply of pure water by boiling it for at least half an hour and preserving it in clean jugs, covered with towels. Water is a generally acknowledged source of danger, and the addition of antiseptics in the amount used for uterine douching is not sufficient to sterilise it; though they are better than nothing in an emergency.

The patient herself should adopt the same precautions, as regards cleanliness, as her attendants, especially frequent warm baths during pregnancy; but during labour they are not advisable, because the water which contains the dirt removed from the surface usually enters the vagina, and cases of fever, apparently due to this cause, have been reported. The external genitals should, however, always be most carefully cleansed and disinfected; formerly vaginal douches were used as a routine, and some obstetricians still employ and recommend them, especially French authorities. At the recent International Congress in Paris Doleris expressed himself strongly in their favour, but the majority of those who have carefully studied the question have abandoned them as more frequently a cause of harm than good (Runge, Leopold, Krönig, Menge). The argument in their favour is, that infective matter is occasionally found in the genital canal. Against this, however, it is urged that such matter very rarely does harm, that the douche is inefficient for its removal, and harmful because it inhibits the normal bactericidal powers of the vagina, washes away the mucus, and so renders labour more difficult, and the vagina more liable to injury, and it may carry infective matter into the cervix and uterus. The strongest argument is, however, the fact that the experience of the vast majority of observers has shown that patients do much better who have not been douched. The management of labour, and especially of the third stage, is of the utmost importance, since the retention of portions of the placenta and membranes is a fruitful source of putrefaction, with its consequent dangers, sapræmic intoxication and pyæmia. (See "LABOUR," vol. vi.)

TREATMENT.—Treatment is both local and general; so long as the disease has not passed beyond the uterus, local treatment is of the utmost importance. Puerperal ulcers were formerly treated very actively—cauterised with chloride of zinc or strong perchloride of iron; but this is unnecessary in ordinary local infections, and useless in systemic poisoning: they are best treated by simple cleanliness, and dusting with iodoform, boric acid, or salicylic acid and starch. When the lochia are offensive a vaginal douche is employed, and if the fever continues the uterus should be washed out. This is a measure not unattended with danger, and requires certain precautions. The instrument employed should be a douche, either a can or Hegar's syphon douche, which can be carried in the obstetrician's bag, but never a Higginson's syringe. The instruments should be absolutely clean, and the water sterilised by boiling for half an hour, and the antiseptic employed should not be a strong poison like corrosive sublimate. Creolin, lysol, or chinosol are perhaps the most suitable; half an ounce of creolin in a gallon of water is an admirable antiseptic solution. The patient should be placed upon her back, a position for many reasons to be preferred to the ordinary lateral obstetric position, because there is less danger of the fluid passing into the Fallopian tubes; the uterus is situated lower, and there is less risk of the tube being contaminated during its passage through the vagina; and also because the operator can see the patient's face, and should the fluid enter the veins he can at once discontinue the process on the first symptom of collapse. The vulva and surrounding parts are first thoroughly cleansed, then the vagina is douched out, a clean glass nozzle being employed, and, in the absence of wounds or ulcers, the surface gently rubbed with two fingers. After this the hands are again disinfected, and a long glass tube, or large Bozeman's catheter, is carefully guided along two fingers, which protect it from touching the vaginal walls, into the uterus, which is then thoroughly douched out. The advantages of uterine douching, though generally acknowledged, are not however universally admitted, and Schrader condemns it under all circumstances. The cases in which it is followed by improvement are, such authorities contend, without exception cases of putrefaction, which usually recover without local treatment, whilst the douche might be the means of conveying septic matter from without, or spreading the germs already present, and, by causing uterine contractions, displace the thrombi in the lymphatics and so favour systemic poisoning. Many other accidents have followed its use, such as reopening of wounds already closed, which offer fresh channels for infection; displacement of thrombi in the veins, permitting the entrance of fluid or air, and even perforation of the uterine wall, followed by a fatal peritonitis. But since, on the other hand, simple sapræmic intoxication may prove fatal, the majority of obstetricians employ intra-uterine douches in all cases where the disease is still limited to the uterus and vagina; but they are agreed as to the absolute necessity for thorough asepsis and most gentle manipulation; and also that they should never be employed after peritonitis or parametritis has set in. Should there be any suspicion of retained membranes or portions of placenta, the uterus should be thoroughly explored with the finger, and these removed. Some authorities prefer mopping out the uterus with absorbent cotton to douching, but to my mind the latter is preferable, but in some cases where the putrefaction continues after douching I have seen good results follow a thorough packing of the uterus with iodoform gauze. The gauze is removed after twelve hours, and, if considered advisable, a fresh packing inserted. A more thorough evacuation of the uterus can be effected by the curette, and brilliant results following this treatment have been reported by E. v. Brawn, Borel, Weis, Charrier, Pinard, Pozzi, and others, but it is a method even more open to criticism than the use of the douche, because the puerperal uterus is difficult to curette thoroughly, and if any putrid matter be left it would infect the fresh raw surface; but chiefly because it is liable to injure or remove the barrier of protective cell proliferation and so provide an open door for systemic invasion. Its employment has for these reasons been strongly opposed by Olshausen, Fritsch, Fehling, and others. Whether it should ever be employed is therefore still an open question, but personally I am in favour of its employment, at least in cases of incomplete abortion.

The most radical of all local methods is the extirpation of the diseased uterus. This has been done with a fair measure of success, and is advisable in cases where an adherent and putrid placenta cannot be safely removed in any other way; also where fever depends upon sloughing myomata; but it may also be indicated in cases in which the uterine tissues have been invaded, but the disease has not extended beyond that organ. It is, however, an exceedingly difficult problem to determine whether this is so in a given case, and to avoid unnecessary mutilation on the one hand, and hopeless interference on the other.

Parametritis and Peritonitis. — In the commencement of pelvic cellulitis an ice-bag should be laid upon the hypogastrium, which is afterwards replaced by cold or warm compresses. The patient should be most carefully protected from chill, and should not be allowed to leave her bed for some days after all symptoms of fever have subsided. Peritonitis is treated in a similar manner, but the ice-bag can seldom be borne, and opium is generally required to relieve pain. The practice which has proved successful in threatened peritonitis after operations, namely, to avoid opium and force the bowels to act, is dangerous in puerperal cases, because the movement of the bowels is antagonistic to localisation and incapsulation of the disease, upon which a favourable issue depends.

Septicæmia.—So long as the disease is confined to the genital canal the local measures already described should be adopted, but as soon as it has passed beyond and invaded the system they are absolutely useless. We are not as yet in possession of any antiseptic which can destroy the micro-organisms in the tissues! Quinine, mercury, salicylic, carbolic, and boric acids, as well as the benzoate of soda, have all been tried without benefit, and most of them do harm by disordering the stomach and intestines, and thus inducing loss of appetite and diarrhœa. Most antipyretics are too depressing, and mask the symptoms without any compensating benefit. Some advise purgatives, but they are better avoided, and on the other hand astringents should not be too readily administered to check looseness, which in moderation is a useful eliminative. Our chief object in treatment should therefore be to assist the organism in its contest with the microbes. This we can do by a free exhibition of alcohol, which acts beneficially in various ways: firstly, it is a powerful antiseptic and antipyretic, it strengthens the heart's action, and by checking oxidation reduces destruction of the tissues. It is best administered in the form of brandy, or whisky, port wine, and champagne. The quantities should be large; twelve ounces or more of brandy in twenty-four hours is generally required. Food should be administered frequently in easily assimilable forms; eggs, milk, and beef tea are the most suitable. The employment of cool baths benefits the patient in many ways, by cooling the surface and improving the appetite; where its employment is contra-indicated, a wet pack, or sponging with water and vinegar, may be substituted. These measures are especially beneficial when the skin is dry and hot, the patient restless or delirious, and especially in cases of septic somnolence. The patients, as a rule, feel better after the bath, their circulation and respiration is improved, the skin becomes soft and moist, and they take food more readily. Baths are contra-indicated in peritonitis and metrophlebitis, because the movement of the patient might, in the former case, convert a local into a general peritonitis, and in the latter because of the danger of starting emboli.

Antistreptococcic serum has not fulfilled the high anticipations which attended its introduction, and the majority of authorities have reported unfavourably upon it.

The treatment which appears to me to have met with most success in this disease was formulated by Runge in 1866, and consists in the free use of alcohol, avoidance of internal antipyretics, cool bathing, and nourishing diet.

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II. AFFECTIONS OF BREASTS AND NIPPLES

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1. NIPPLES

(*a*) *SORE NIPPLES.*—Under this term several diseased conditions of the nipple arising during lactation are included, which are of great clinical importance owing to the relation they bear to mastitis and mammary abscess.

The commonest condition met with is a simple abrasion of the nipple, the result of a loss of epithelium. The first stage of abrasion is a simple erythema. The epithelium is next denuded at several points, leaving the subjacent papillæ unprotected, and if this condition is allowed to go on a fissure of the nipple results.

The denuded areas which follow on a simple erythema are usually at the apex of the nipple, and next most frequently at the sides and base. Basal fissures may extend so deeply, from repeated attempts at nursing, that the nipple may be entirely severed, or left attached merely by a few lactiferous ducts.

The *predisposing causes* of sore nipples are:—shortness of the nipple, undue thinness of the epithelium, and prominent papillæ with deep intervening sulci, which tend to imprison shed epithelium and drops of milk; these combining to form a crust, the non-removal of which favours atrophy of the underlying epithelium. Neglect and want of cleanliness during pregnancy, and pressure of tight corsets, which may prevent the development of the nipple, are important ætiological factors.

The *direct cause* is injury set up by the gums and tongue of the infant during suckling. This is most apt to occur if suckling be delayed until the breasts are engorged, if the entire nipple be not taken into the child's mouth, or if the nipple is not properly developed, or is depressed.

The unprotected papillæ bathed in milk and blood form an excellent nidus for the culture and growth of micro-organisms. Bacterial infection may result from the fingers of the nurse or mother, from the child's mouth, or from soiled clothes, and thus what was originally a simple irritation is converted into a septic wound. Bacilli and cocci, including the staphylococcus aureus and albus, have been found by Bumm in fissures of the nipple. The *oidium albicans* in cases of thrush, and micro-organisms, may be transmitted directly from the mouth of the child, and it is possible that some forms of stomatitis in the child may be caused by micro-organisms present in the fissured nipple.

Fissured nipples are more common in primiparæ, and in women with delicate skins, especially blondes. Abnormal states of the mother's milk may also predispose to fissure of the nipple, or aggravate an already existing fissure.

Symptoms usually begin from the third to the fifth day. Excruciating pain is complained of when the child is put to the breast. The temperature may rise to 104° F., either as a result of septic absorption or from the deep impression made on the nervous system by the intense pain. The nervous apprehension of the pain may even cause convulsions to supervene, and may seriously interfere with the patient's general health.

Treatment.—Prophylactic treatment should begin during the last two or three months of pregnancy, when special attention should be directed to the avoidance of pressure by corsets. The nipples should be washed night and morning with soap and cold water, and then bathed with some astringent or spirituous fluid, such as solution of alum, tincture of quinine or arnica, brandy, whisky, or eau-de-Cologne. Small depressed nipples should be gently pulled out daily with the finger and thumb, which serves to stimulate and bring into action the muscular fibres. Inunction with lanoline or simple ointment facilitates the pulling out of the nipple. Care should be taken not to over-manipulate the nipple late in pregnancy, as uterine contractions may thus be set up.

Depressed or invaginated nipples may be pulled out by means of the breast-pump, or oral suction by another healthy woman, or by the mouth of a bottle just emptied of hot water. Strips of adhesive plaster may then be carefully and judiciously applied to retain the nipple in its normal position (Henry Davies). In severe cases, Kehrer's operation of mammillaplasty may be performed.

Attention should be paid to the cleanliness of the nipple and of the child's mouth from the beginning of lactation. The child's mouth should be washed at least once daily with a saturated solution of boracic acid. Before and after each act of suckling the breasts should be washed with boric solution, or 1 in 2000 corr. sublim., and thoroughly dried. If the nipples are carefully dried the child will only absorb an infinitesimal quantity of mercury.[1] If any erythema is present a protective ointment should be applied, such as ung. bismuthi alone, or mixed with an equal quantity of boracic acid ointment. Compound tincture of benzoin or hazeline are also useful applications, which may be used alternately with the ointments. If there be erosion nothing acts so well as ichthyol ointment, 15 to 20 per cent with lanoline, or iodoform ointment, gr. x. to ℥j. Dusting with powdered tannic acid, or painting with a solution of silver nitrate, 2 per cent, may often be found useful.

For a deep fissure a fine pointed stick of silver nitrate should be applied. A solution of chloral hydrate (4 per cent) may be tried, preceded by the application of a 5 per cent solution of cocain.[2] Corrosive sublimate solution, 1 in 2000, should also be used as a wash.

To give time for the healing process to occur, a nipple shield should be used if it can be borne, and if it does not tend to aggravate the fissure. If the shield cannot be borne the breasts may be relieved artificially by massage, which may be continued for four days, nursing being again attempted at the end of that period. If a nipple shield is used it must be kept scrupulously clean, and when not in use should be kept in boracic acid solution.

A slight fissure will usually heal up in about twenty-four hours with proper treatment, but in severe cases it may take longer. It is rarely necessary for the mother to give up nursing entirely, unless a mammary abscess is imminent, or unless the pain and distress are so intolerable that the patient cannot persevere.

(*b*) *Deep Inflammation and Abscess.*—Inflammation of the deeper part of the nipples is rare. It may attack the lactiferous ducts or the connective tissue of the nipple, and may end in resolution or in the formation of a small abscess. If pus forms in the ducts, it becomes evacuated through the normal apertures, and is apt to be swallowed by the child. If the connective tissue is involved a painful abscess is apt to form, which may either burst spontaneously or require incision, after which it usually heals rapidly with antiseptic treatment. Lactation should be stopped for a few days. In using the bistoury the greatest care must be taken not to divide a milk duct transversely.

(*c*) *Eczema, scabies, herpes zoster, diphtheria, thrush* and *syphilitic ulcers* may affect the nipple. Eczema will be considered under affections of the areola. Syphilitic ulcers are to be treated on the ordinary principles of general and local treatment. If the child presents no symptoms of syphilis it should be weaned. These ulcers may be difficult to recognise as syphilitic; in such cases the enlargement of the axillary glands, sore throat, and a faint roseola on the skin should be carefully looked for.

(*d*) *Anomalies and Defects in Conformation.*—The nipple may be absent congenitally, or from the result of injury or suppuration in infancy. The nipples may be small, ill-developed, or depressed, and there may be supernumerary nipples. The greatest variety exists in their development in different women. Some are bilobed or have an exaggerated foliaceous arrangement of the papillæ with deep clefts and divisions. These latter are more apt to excoriate and crack during lactation, for the reasons already given, and depression or invagination of the nipples is probably one of the most frequent factors in the ætiology of mammary troubles during lactation. These defects should be remedied as far as possible by treatment during pregnancy, as already described.

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[1] The child should not be put to the breast too frequently, and each nursing should be limited to fifteen minutes at longest.

[2] Films of Unna's glycerine jelly form good protective applications, with which may be incorporated ichthyol, carbolic acid, resorcin, boric acid, lead, zinc, tannin, etc.

2. Affections of the Areola

(*a*) Eczema of the areola and nipple is more frequent in blonde women with delicate skins. It is often difficult to cure and is apt to be obstinate under treatment, possibly from the presence of a staphylococcus in the milk, which is constantly reinfecting the areola (Stumpf). The predisposing causes are the moist and sodden condition of the areola, the result of nursing, the friction of clothes, and the entrance of micro-organisms into small excoriations or fissures. It may also arise from a discharging sinus, causing skin infection in a neglected case, combined with the results of poulticing in such cases. It is characterised by much itching and burning, by a moist discharge which stiffens linen and forms yellowish crusts. It is apt to spread to the adjacent skin, and if neglected may lead to fissure and mastitis.

Treatment.—If possible the condition should be prevented from becoming chronic. To this end the parts should be kept as dry as possible, and the application of the powdered oleate of zinc produces, as a rule, gratifying results. In bad cases lactation should be stopped, or a gutta-percha nipple shield may be tried. The crusts should be removed by bathing them with either a weak solution of bicarbonate of soda, to which oatmeal flour is freely added, or warm rice-water, or a boracic starch poultice may be applied. After the crusts are removed in this way various applications may be tried. When there is much hyperæmia mild soothing remedies should be used, and more stimulating treatment later. Ointments of zinc, salicylic acid, carbolic acid, *liquor carbonis detergens*, or ichthyol, and diluted citrin (Velpeau) or sulphur ointments. More stimulating remedies, as resorcin, nitrate of silver, and corrosive sublimate may be used later. When acute symptoms have subsided an ointment of nitrate of lead (gr. x.-xv. to ℥i.) is very useful (Fordyce Barker).

(*b*) *Cellulitis, adenitis,* and *abscess of the areola* is simply an extension of the similar condition from the nipple (already considered). This is rarer than suppuration within the breast itself. The condition is sometimes called supramammary abscess (abscès de l'aréole). When suppuration occurs it is better not to incise till a distinctly pointed swelling is evident, in case of injuring a milk duct.

Proper attention to the nipples to a great extent prevents this condition, and resolution generally occurs if the exciting cause, the irritation of suckling, be removed.

Small boils or pustules may develop in the sebaceous follicles of the areola from suppuration.

(*c*) *Anomalies of Areola.*—The writer has met one instance where suckling was rendered impossible by the escape of milk from Montgomery's tubercles while the child was at the breast.

3. Affections of the Mamma

(*a*) *Mastitis*, or inflammation of the breast, commonly called a "weed," may affect both breasts simultaneously, but more frequently affects one (usually the right). It is more common in primiparæ. Blondes and lymphatic subjects are most subject to it, and it is rarely met with after the fourth pregnancy.

Since more attention has been paid in recent years to prophylaxis, its frequency has fallen from about six per cent to three per cent in confinements in private practice, and at the present time a case is almost unique in a lying-in hospital.

There are four periods during the puerperium when mastitis is most likely to occur :—

(1) In the first month—the stage of mutual adaptation.

(2) When there is sudden arrest of suckling, causing liability to milk stasis.

(3) At the period of appearance of the first teeth, when the nipple is exposed to injury.

(4) At the period of weaning, when engorgement may occur from irregular emptying of the breasts, or when the child, failing to get nourishment, shows its dissatisfaction by tugging at the nipple.

Varieties of Mastitis.—(1) Parenchymatous or glandular (the most frequent form).

(2) Subcutaneous.

(3) Postmammary or subglandular.

These varieties may coexist, and frequently a mastitis begins as a parenchymatous form, and then approaches the skin surface of the gland.

Causes. — The puerperal breast, being an organ frequently engorged with blood, and containing an animal fluid, forms consequently a convenient nidus for the proliferation of organisms. The dependent position of the glands further favours congestion, and owing to their situation they are liable to injuries. It is now abundantly proved that mastitis is invariably caused by the action of organisms. Mere stasis of the milk will not produce inflammation, unless the milk contains abundance of bacteria. Kehrer has sealed up the nipple with collodion, and no inflammation ensued from the resulting engorgement and stasis. Stasis is a frequent precursor of mastitis, but never in itself a cause.

Organisms can gain access to the breast through its numerous ducts when there are any abrasions on the nipple or areola, and as such breaches of surface are frequent in lactating women, the entrance of pyogenic organisms readily takes place. Nowhere are the usual organisms of the skin found in greater numbers than in the axilla and on the mammary areola, and micro-organisms exist in special abundance in the moist fossa at the base of the nipple. These organisms are mostly pyogenic, and thus it is not to be wondered at that the least abrasion of the nipple becomes a septic wound. Organisms may also be conveyed to the nipple by the child's mouth, the hands of the mother, a dirty nipple shield, etc. Sometimes the lesions on the nipple through which absorption has taken place are so small as to require a lens to distinguish them.

Micro-organisms have the special power of coagulating caseinogen on gaining access to the milk. Escherich believes that, in puerperal septic conditions, microbes, which have entered the blood from lesions in the genital canals, may find their way into the milk and set up mastitis. Hence the importance of keeping the genital tract aseptic.

Congestions and Milk Engorgements.—Many of these conditions are purely physiological, as when the milk first appears, and is accompanied sometimes by pain and slight rise of temperature. Milk engorgement may occur when suckling is suddenly interrupted, as by the death of the child, or when nursing has become painful from tender nipples. The breast then swells, becomes hot, painful, and congested, while localised areas of induration can be felt, which are loaded milk ducts. The superficial veins become large and prominent. This condition, especially if associated with neglected sore nipples, is almost certain to go on to mastitis and abscess formation, owing to the easy absorption of organisms.

Various causes may interfere with the milk flow, thus leading to engorgement in the milk ducts of a part, or even the whole of the breast, *e.g.* hypersecretion, chill (which may occur quite as readily from the patient's night-gown being soaked from an overflow of milk through the night, as by direct exposure), or blocking of a duct by some inspissated secretion.

Treatment of Mammary Engorgement.—In the first place any abrasion or sign of excoriation about the nipples must be rendered aseptic with a mercurial lotion. In mild cases some evaporating lotion, as eau-de-Cologne or vinegar diluted with water, gives relief. In addition, graduated pressure should be adopted by means of layers of cotton wool kept firmly applied by bandages, or by an ordinary tightly-fitting slip-bodice. If the breasts are pendulous, slinging them in a silk handkerchief is a great comfort if pressure cannot be borne. Suckling on the affected side must be desisted from, and a breast-pump, or preferably careful massage, substituted. When there is great engorgement more vigorous measures are required. Free saline purgation, antiseptic fomentations, and a dry and restricted diet are the first indications. The breast-pump should be used, and the breast massaged from the base towards the nipple with warm olive oil alone, or combined with an equal part of belladonna liniment. Frequently the breasts can be kept empty by means of massage when the application of the breast-pump is painful and unsatisfactory. The breast-pump only withdraws milk from the large ducts near the nipple, so that to empty the breast thoroughly the use of the pump should be combined with massage. If the child is off the breast, belladonna or atropine can be given internally, combined with full doses of iodide of potassium. Sculptor's clay has been recommended as an application in mastitis. It is spread thickly under a bandage over the breast, leaving the nipple free, and is renewed morning and evening.

The temperature may rise to 102° F. or 103° F. in simple engorgement, and thus simulate abscess formation.

(*b*) When symptoms of abscess show themselves, massage and compression must cease, and the abscess is treated on ordinary surgical principles.

(*c*) *Milk Nodes.*—Owing to the constriction of one or more lacteal canals, inspissated milk may collect and remain for an indefinite period, forming swellings in the breast.

Treatment.—Promote their absorption by massage, with the application of a five per cent oleate of mercury ointment.

(*d*) *Galactocele* is the result of permanent occlusion of a lactiferous duct. The retained milk forms a cystic tumour which may require surgical interference.

(*e*) *Fistulæ* may be of two kinds—first, the result of an abscess which has not closed; and second, a communication between the skin and a lacteal duct, caused by injury to the duct by a penetrating abscess, or by the surgeon's knife. In either case lactation should be given up.

(*f*) *Anomalies.*—Congenital absence of one or both breasts may occur, or more frequently there may be a small breast which is valueless for lactation. There may be supernumerary mammary glands, which for the most part are functionless.

(*g*) The puerperal mamma may be affected with tubercle, erysipelas, and molluscum contagiosum, the latter derived from the child's face.

4. Conditions interfering with Suckling

See also "Infant Feeding," vol. v. p. 215.

(*a*) *Artificial Arrest of Lactation.*—Lactation may be arrested at three periods—(1) immediately after delivery, before full secretion has been established; (2) during the course of lactation at any time; and (3) at the end of the period of lactation. The secretion can be most easily arrested, and with least disturbance to the patient, at the first or third of these periods.

Means of Arrest.—In the first period this can generally be accomplished by (α) pressure, as already described under the treatment of "mastitis," if possible before engorgement has begun; (β) purgation—early administration of saline purges—and a "dry diet"; (γ) gentle massage; (δ) abstraction of a small quantity of milk by the breast-pump to prevent dangerous engorgement during the first few days; (ϵ) iodide of potassium (gr. xx. to xxx.) and belladonna internally; locally some preparation of belladonna, or atropine ointment (gr. j. to ℥j.). Belladonna plasters may be applied in such a way as to leave the nipple uncovered. Plasters, however, sometimes cause irritation, and inflammation may go on unrecognised beneath them. A plaster 6″ × 6″ is sufficient for each breast.

In the second period compression, free purgation, and dry diet are the chief means of arrest. After massage and suction during this period the breasts tend rapidly to refill, and therefore such treatment is not so satisfactory in this as in the first stage. If, however, nodular masses form in the breast, indicating insufficient milk drainage, early massage is necessary to prevent the possibility of mastitis. If the massage causes pain, the application of a mixture of equal parts of glycerine and extract of belladonna, over which hot fomentations are applied, gives great relief, and so permits of the subsequent use of massage. Internally iodide of potassium and belladonna should be given.

In the third stage the arrest of the milk flow is simply natural weaning, and is discussed under that heading in the article on "Infant Feeding." Any slight tension of the breast which may occur at this time, when a "nursing" has been omitted, can be reduced by gentle massage with or without a short application of the breast-pump.

(*b*) *Abnormalities of Human Milk.*—These have already been fully discussed in the article on "Infant Feeding." It only remains to be added that healthy mothers' milk does not come from the breast absolutely sterile. The micro-organisms commonly found are *staphylococcus pyogenes albus* and *aureus*, which probably find their way into the milk from without through the milk ducts. On the other hand, as already stated, organisms may reach the milk through the blood in women suffering from septic diseases. The cocci which may be ordinarily found in milk produce no ill effect, and they seem to be destroyed by the bactericidal action of the intestine in healthy children. Weak children do not possess this action to the same extent, and so the cocci may flourish in the intestine and produce various infantile disorders. If the milk contain more virulent organisms, as in mastitis and puerperal fever, the child may be seriously affected.

Blue milk is due to the presence and development of the *bacillus pyocyaneus.* Red milk may be due to the presence of blood, or may result from the action of the *micrococcus prodigiosus,* which sometimes grows with great rapidity in milk allowed to stand, giving it the appearance of blood.

Green and yellow milks are also organismal in their origin. Bile pigment and pus may pass into the milk. In all such cases weaning is necessary.

Jorisenne has recorded a case of fœtid milk in the mamma, when the milk became fœtid if there was any unduly long interval between the woman's nursings, becoming sweet again when she nursed regularly. The child was sick when the milk was fœtid, but the mother suffered no discomfort except from the smell.

Closely allied to the bacteriology of milk is "Lactation Immunity," which, though of great interest and importance, hardly falls within the scope of this article. A good account of this subject is to be found in the *Science Progress* for May 1894, by Buckmaster.

LITERATURE.—The following works contain bibliographical references to most of the important books and articles on the subject:—1. Norris. *American Text-book of Obstetrics,* vol. ii. 1895.—2. Marmaduke Sheild. *Diseases of the Breast,* 1898.—3. *System of Gynæcology and Obstetrics,* by American authors, vol. ii. 1889.—4. Roger Williams. *Diseases of the Breast,* 1894.—5. Charpentier. *Des Accouchements,* 1889.—6. Muller. *Handbuch der Geburtshülfe,* 1889.—7. Spiegelberg. *Text-book of Midwifery.* Sydenham Society, 1888.—8. Fordyce Barker. *Puerperal Diseases,* 1874.

III. FEVER IN THE PUERPERIUM, ETC.

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1. Fever in the Puerperium due to Causes other than Septic Infection

A rise of temperature in the puerperal state should always be regarded as evidence of some septic infection unless there is definite proof to the contrary. Low continued fever for a week or ten days without any very severe constitutional disturbance, often attributed to the changes in the mammæ connected with lactation, is much more often due to a subacute inflammation in the pelvis. It is this manifestation of sepsis in the puerperium which is so frequently at the time overlooked, but which is the cause of so much suffering in parous women, and accounts for a large proportion of those chronic cases which fill the cliniques of the gynecologist.

Fever apart from sepsis does, however, occur. It may arise from reflex irritation. The best example of this is the fever which, especially in neurotic patients, sometimes accompanies the engorgement and distension of the breasts about the third or fourth day. It is seen also when the nipples are cracked and fissured, though here it is less easy to eliminate a septic element. The fever, unless mastitis actually sets in, quickly subsides as the breasts become softer when suckling is fairly established, and is relieved by a mild saline purge and gentle massage of the breasts with warm olive oil.

Emotion may be a cause of fever in the puerperal as in the non-puerperal state, and in the weakened condition of the puerperal patient is specially apt to be so. The sudden announcement of some bad news, the death of the baby, the dread of exposure in unmarried girls, worry over the non-arrival of an expected letter, are instances of recorded cases of this so-called emotional fever.

Acute constipation can also undoubtedly give rise to very considerable febrile disturbance in the puerperium. The temperature may be very high, and from its sudden onset the cause may be overlooked. The heavy breath and furred tongue will indicate the treatment, and speedy relief will be got by the administration of two grains of calomel followed in a few hours by a dose of castor oil.

A febrile reaction may follow a sudden exposure to cold. The fever may be ushered in by a rigor; it at any rate follows suddenly on the exposure, so that the history makes the case clear. It is of short duration, and is speedily relieved by the obvious treatment of a hot drink and the comfort of a hot-water bottle.

Any of the acute or chronic febrile diseases may, of course, attack the pregnant woman, and may persist in the puerperal state and form a serious complication. The cause of the rise of temperature in the great majority of these cases will be obvious. In some, however, the original disease is easily overlooked, and the fever may be regarded as septic in its origin. An acute exacerbation of fever, so often observed in phthisical patients during the puerperium, may cause anxiety in this way. It must be remembered also that zymotic disease in its incubation stage, before the fever has developed, undoubtedly predisposes to the onset of labour. Two cases of fever in the puerperium in the writer's experience, at first regarded as septic, proved ultimately to be typhoid, and in a third case, during an epidemic, a small-pox rash which developed on the third day cleared up the diagnosis. All these patients died. It was only after the correct diagnosis was made that any history of indisposition previous to the labour could be got from the patients or their friends. Influenza attacking a puerperal patient may for a time be difficult to differentiate from a septicæmia.

Fever in the puerperium is fortunately then not always due to sepsis, but, as before stated, great care must be taken before assigning to it any other cause. An early intra-uterine douche, carefully given, in a doubtful case can do no harm, and may do much good in averting a general infection, while, if the operation is followed by a marked reduction in the temperature, it will form a valuable aid to diagnosis.

2. Sudden Death in the Puerperium

Puerperal Venous Thrombosis and Embolism.—During pregnancy the blood contains an excess of fibrin, the amount increasing as gestation advances. This increase of fibrin probably plays an important part in favouring coagulation of the blood in the uterine sinuses after labour is over. It has, however, also a pathological interest, as it predisposes in the puerperium to thrombosis in other parts. The commonest sites are the iliac and femoral veins, but it may occur, according to Playfair and others, primarily in the pulmonary arteries. The separation of such a thrombus and its entrance into the circulation, and its final arrest in some branch of the pulmonary artery, or the formation of a clot in the right side of the heart and its gradual extension along the pulmonary artery, are the causes of the majority of those cases of tragic and sudden death which are met with in puerperal women. The accident rarely occurs before the end of the second week, and, as a rule, there is no warning that anything is wrong. The patient is apparently in perfect health, when suddenly she is seized with intense dyspnœa and pain in the chest. The face in some cases is pale, in others deeply cyanosed; in all it is expressive of great agony. The heart's action, at first exaggerated and irregular, soon becomes feeble and flickering, and the patient dies in a few minutes.

This is the general termination of cases of pulmonary embolism, but in some cases, after a severe attack of dyspnœa, the symptoms slowly abate and recovery takes place. In such a case the thrombus, which is small and blocks only a smaller branch of the artery, is gradually absorbed. In still another class of cases there may be a temporary alleviation of the distressing symptoms, followed later by increasing dyspnœa and cyanosis, and death in a few days. Here there is probably a gradual thrombosis extending from the site of the embolism.

As a rule, death is so sudden that the question of treatment does not arise. In the rare cases not immediately fatal stimulants should be freely given by the mouth or hypodermically, and mustard placed over the heart, and after the acute distress of the attack has passed the patient must be kept at absolute rest, all attempts at movement being strictly forbidden. Prophylaxis is of greater importance. In the treatment of a case of puerperal thrombosis, as in phlegmasia alba dolens, the affected limb must be swathed in wool, and kept absolutely at rest, it may be for weeks, until the thrombosis has become so firmly attached to the vessel wall that its separation is impossible. Even gentle massage of the affected limb is always dangerous until six weeks from the time the phlegmasia was first noticed.

A much rarer cause of sudden death than that mentioned is the entrance of air into the circulation. The place of entrance is generally the open uterine sinuses at the placental site. The accident has followed intra-uterine manipulations as in turning, and during the process of an intra-uterine and also vaginal douches, where air has been forced in along with the fluid.

The spontaneous entrance of air into the uterine sinuses must be very rare, though such cases have been recorded. The symptoms are somewhat similar to those met with in pulmonary embolism.

Sudden death in the puerperium may arise also from heart disease, from rupture of the heart, from rupture of an aneurysm, or from cerebral hæmorrhage. Many patients die from a sudden acute uterine hæmorrhage, while in others the cause seems to be shock or syncope following a tedious labour.

3. Puerperal Hæmatoma

An interstitial effusion of blood into the tissues of the pelvis, due generally to the rupture of a vein and the formation of a circumscribed tumour, is a rare, but when it does occur may prove a very serious complication of the puerperium. The situation of the blood tumour varies. In the majority of the cases it is in the vaginal wall near the vulvar orifice through which the swelling may bulge. It may, however, form in the cervix, in the peri-uterine connective tissue, or under the skin of the perineum, from which it may extend posteriorly into the gluteal region or anteriorly to the abdominal walls. It occurs generally spontaneously, and is then due either to the increased venous pressure which is present during labour, causing rupture of a diseased vessel, or to the direct pressure of the fœtal head in its descent through the pelvis. A varicose condition of the veins would seem likely to predispose to this accident, but this is denied by most authorities. It may be caused artificially by direct injury of a vessel in using forceps. Not infrequently the hæmatoma is noticed during the labour, but more often the pressure of the descending part against the side wall of the pelvis prevents any effusion till labour is over, when it slowly increases in size, and may continue doing so without rupture for twelve or even twenty-four hours. In rare cases the tumour does not develop until the second or third day. In these cases the rupture of the vessel is due to what has been called a pressure necrosis.

The size of the swelling varies. Generally no larger than the fist, it may be as big as a large cocoa-nut. Pain is generally a prominent symptom, the severity of which depends largely on the size of the tumour. By pressure against the bladder or rectum it may give rise to severe tenesmus and straining. Where the effusion of blood is diffuse and not circumscribed, or where the tumour is very large, there may be symptoms of acute hæmorrhage.

The diagnosis is, as a rule, easy, because in the majority of cases the tumour is visible and can be noticed to slowly increase in size. The swelling has, however, been mistaken for the placenta, for inversion of the uterus, for prolapse of the uterus, and even for the fœtal head.

Prognosis.—(*a*) As a rule the effused blood is slowly absorbed; (*b*) rupture of the tumour may take place and recovery follow; (*c*) the formation of an abscess the result of septic infection, without rupture, or septic infection after rupture; (*d*) death from hæmorrhage, with or without previous rupture of the tumour.

Treatment.—Should the tumour develop during labour and form an obstruction to delivery, it must be incised and the blood-clot removed. If the bleeding vessel can be secured, the case can be left alone till the labour is over; but if, as is more likely, this is impossible, then forceps should be applied to bring the head down into the vagina, till by its pressure over the site of the tumour the hæmorrhage is controlled. After delivery another attempt may be made to ligature the bleeding vessel. If this cannot be found, then the cavity must be tightly packed with iodoform gauze and an ice-bag applied to the parts externally. There is a great risk of a septic infection, of course, from the decomposing lochia where it has been necessary to incise the tumour, so that the greatest care is necessary to keep the parts sweet by antiseptic douching and bathing of the external genitals.

Should the tumour develop after labour, then treatment should be directed towards controlling the hæmorrhage by pressure and the application of cold. Pressure can be brought to bear over the swelling by the introduction into the vagina of a large Barnes bag; an ice-bag should also be placed over the vulva, and any straining, if possible, prevented. If by these means the hæmorrhage is stopped, as shown by the tumour ceasing to get larger, then absorption of the effused blood will, as a rule, go on slowly. To lessen the risk of abscess formation which may result from septic infection, the vagina must be frequently douched and the external part frequently cleansed with some antiseptic lotion.

If the swelling, once formed, rapidly increases in size, indicating a severe hæmorrhage, then all attempts by pressure and cold may fail to arrest the bleeding, and in order to prevent the sac rupturing it may be necessary to incise the swelling and search for the torn vessel. This will, however, be rarely necessary, and should, if possible, be avoided, because of the risks of septic infection. In some cases where the sac has not been opened, in spite of all care the effused blood will become septic and suppuration supervene. As soon as this is diagnosed a free opening must be made into the most dependent part of the swelling, all blood and pus cleared out, and the cavity, after cleansing, packed with iodoform gauze, which is changed at least once each day.

IV. PUERPERAL INSANITIES

1. Observations on the Nature, Etiology, and Pathology of the Insanities of Pregnancy 172
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(Note.—Puerperal insanity is the dramatic and most significant variety of the mental diseases associated with child-bearing, but it can only be properly considered as one of a group to which it gives its name.)

1. Nature, Etiology, and Pathology.—Insanity always signifies some dyscrasia—a more or less profound nutritive disturbance in general, some incompatibility in the ingredients which the blood supplies for the tissues' nourishment. Hence follows a loss of balance between waste and repair. That may be what I have called in the general article on "Insanity" (vol. v. p. 345) a state of "surfeit," or it may approach to a more simple anæmia; but in any case the result is inanition and irritation of the nervous system and of the other tissues. But, besides the general physiological instability, a particular mental instability is also implied by insanity—some failure of balance between the various nervous activities which contribute to mental life, some discrepancy between sensibility and the capacity for effort. No form of insanity illustrates so well as do the insanities of pregnancy these aspects of mental pathology—perversion of nutrition, reflex irritation, and excess of mental effort. There are three recognised varieties of insanity of child-bearing—the pregnant, the puerperal, the lactational—though they are best regarded as a serial development of a protracted process. Each of the three has its characteristic dyscrasia. An account, even approximately exact, of the chemistry of these states is still quite impossible. Very great importance is now being attached to the factors of auto-intoxication in the etiology of insanity, and quite properly. But we do well, I think, to associate our newer knowledge and impressions with the old conceptions of malnutrition. In particular, I would emphasise the importance in the cases now considered of simple starvation of the cerebral tissues either from some poverty of the blood, for instance, or from defective cardiac action, as well as of the presence of pernicious by-products of metabolism or of defective elimination. We cannot dissociate these factors

in etiology. As Dr. Lackie points out (vol. ix. p. 499), many of the changes in pregnancy formerly called physiological are now regarded as due to toxæmia; and we must take the wide view of child-bearing as a process which at once depletes and poisons, exhausts and upsets, the nervous system and every other system. During pregnancy the maternal organism is called upon to bear the burden not only of its own metabolism, but of that also of the fœtus, and we must bear in mind the great frequency, especially in primiparæ, of disordered digestion and impaired excretion, dyspepsia, a poor or perverted appetite, constipation, possibly some uræmia, "hepatic inadequacy," and muscular inertia from insufficiency of out-door exercise. In the puerperium the maternal economy, suddenly called upon to adjust itself to a quite altered blood-supply on the escape of the fœtus, often finds itself hampered by having to deal with the products of something like septic absorption. And during lactation, just following the strains of the pregnant and the puerperal metabolism, the constitution is drained by a novel, continuous, and expensive secretion. But the nervous factors are also important—the reflex irritations which are inevitable, and the nervous reactions which are not less so, both of which imply nervous differentiations appropriate to the maternal state. We cannot but admit the nervous strain of pregnancy, however well managed, however perfect the metabolism, however aseptic the various tissues—the variety of impulses which beset the brain, from a growing and quickening tumour, partly subconscious, partly impressed upon the attention forcibly or even painfully; the acute impressions of delivery, the sudden pelvic emptiness, the cessation of fœtal impulse, and in its place the painful irritation of a uterus in involution; then another reflex stimulation, usually painful, when the mammæ have to suffer periodic tension and relief.

And again we must attach importance to the mental condition incidental to child-bearing. The emotional state during pregnancy is one of tension. The young mother is usually apprehensive, fearful of some accident to herself or to her child; ready to foresee domestic trouble, or even catastrophe; distressed by her physical incapacity, and apt to feel herself a burden; fanciful and nervous, ready to believe that she is no longer acceptable to her friends, and that she has lost her husband's love. In the puerperal state a great mental reaction occurs. It is usual to have emotional relief; conjugal feeling is forgotten in the maternal, which develops with an intensity that is frequently ferocious, and the new-made mother is actively inclined and restless, itching to be up and about, and as keen to be living an active life as a hen that has hatched a brood. We must note here that this reaction shows itself in insanity, so that, while the type during pregnancy is melancholic or delusional, as it also is during lactation, the insanity of early puerperium is one of acute mania. During lactation, again, the conditions are those of a reaction. The return to active life has proved exhausting, and the patient is weary in body and in spirit; her happiest expectations are not being fulfilled, and her courage is being sapped by the constant drain on her physical resources; very easily the patient slips from the hopefulness and sense of energy of the puerperium to a state of depression and annoyance.

For those who take a broad view of these insanities, and understand the manifold factors to be taken into consideration, I would cite these as very significant facts—that the risk of insanity is increased in cases where morning sickness has been intractable, or where uræmia has been considerable; in those also in which the puerperal processes have gone septic, and in the mothers of illegitimate children. These facts severally illustrate the importance of starvation, of auto-intoxication, of auto-infection, and of worry in the production of insanity at this period. I have dwelt disproportionately upon this aspect of the subject because it is of the utmost importance in treatment. To manage his cases properly from the point of view of preventing insanity, the practitioner must, if he has a pregnant patient who is of a neurotic type, and especially if her heredity or her history makes him afraid lest insanity supervene, he must have regard to conditions which deprive the patient of sufficient nourishment, to those which poison her, whether by non-bacterial or by bacterial products, and to those which add to the already great mental strain of the occasion.

The pathology of these insanities is indeterminate. Of the acute forms —for instance, an acute melancholia of pregnancy or an acute mania of puerperium—the histological appearances would likely be proliferative and degenerative changes in the endothelial elements of the membranes, connective tissue proliferation in the adventitia, and infiltration with leucocytes in the vessel walls, and especially primary degeneration of the cortical nerve-cells, varying with the gravity of the case, both in its degree and in the extent of its distribution. One would also find in these acute cases after death intense congestion of the cerebral tissue in areas and softening patches. These appearances, however, are common in all acute insanities. The topical pathology is all-important, and we know nothing of it; yet there must be some physical counterpart, for example, of the almost constant change in appetite and affections which characterise these insanities. Also, the chemical pathology is unknown; the products of para-digestion, which presumably occur in the dyspepsia of pregnancy, the toxins which are developed in the stomach and bowels, the bacteria and their products which develop either generally or locally in such cases, are not distinctive. It is their presence in the organism, along with the almost constant nervous conditions of these cases, which determine their characteristic results. In short, the insanities of pregnancy are to be regarded as occasioned by malnutrition—by inanition, or by toxæmia, or by both, occurring in nervous subjects at a time when they are already subjected to the strain of nervous developments characteristic of incipient or actual motherhood. As we shall see, these factors can and should be dealt with in treatment, especially in its preventive aspect.

2. Clinical Varieties.—All the insanities of pregnancy may be said to show mental exhaustion in the early stage—a weariness of the rational functions and of the affections. In the insanity of pregnancy and in that of lactation the development is usually one of melancholia. In puerperal insanity the condition rapidly develops, as a rule, into an acute mania of the delirious type. Most cases show a well-marked perversion both of sexual desire and of the conjugal and maternal affections. One would expect that during pregnancy the capacity for sexual pleasure should diminish, but it is fortunately not normal that an intense loathing of the idea of sexual converse or a perverted appetite for vagrant indulgence should develop; yet these are common to pregnant women who become insane. Similarly, it is usual for the mother to turn against her husband or her child, and quite frequently she finds some fantastic substitute for the affection with which she has parted. Most cases are prone to impulses of a violent kind, and often towards those to whom she is normally most attached. There is nearly always confusion as to time and place and people, and a gradual loss of the sense of identities. Nearly every case manifests disturbances of sensory impressions, is beset by paræsthesias, or

by illusions which to her disordered judgment seem fit reason for the delusions of misfortune or of grandeur which supervene.

(*a*) *The insanity of pregnancy* is the least frequent of the three varieties now considered. But, in my experience, many lactational cases have begun during pregnancy, and have merely been tided over. The seventh month is rather more critical than the others, and, if the patient goes past that, and if no septic development occurs in the puerperium, nothing serious may happen until well on in lactation. It may safely be said that all cases begin with mental depression, and the melancholia will continue and be a feature of the case unless some gross neglect of bodily functions, some sudden shock or some acute illness, precipitate the case and lead to mania. The usual case becomes indifferent and apathetic, and a considerable number become stuperose. A very large proportion become suicidal, and a considerable number have impulses of a homicidal nature. In nearly all melancholias of pregnancy the sensibility of the patient will be found reduced, and developments towards paræsthesias—perverted skin sensations, or tactual, or olfactory, or gross feelings of "internal disease"—are common.

(*b*) *Insanity of the Puerperium.*—This is perhaps the most dramatic, because the most sudden and demonstrative, of all insanities. After a difficult pregnancy and, from the obstetrical point of view, an unsatisfactory puerperium, the patient rapidly becomes delirious. Her appetite for food ceases, she passes an insufficient amount of urine, she becomes constipated, the lochia are inhibited, the patient has gone septic. It is not merely a local disorder: the whole system is obviously toxic. The mental accompaniments, after a more or less brief stage of depression, are that the mother ceases to be careful about her child, ignores her husband, is perverse in her temper, and more and more unmanageable, until manifest delirium with rise of temperature supervenes. The case rapidly develops, and takes on the characters of acute delirious mania, but with a shallower delirium, that is, a slighter oblivion, than in other comparable states. For example, the patient will dance, and sing, and shout, and her expressions of delight or of excited activity will increase in response to stimulation. She will probably recognise her husband and repel him, at the same time she will rush into the arms of her medical attendant or of a stranger. Her violence will be destructive, and she will throw her child across the room as readily as she will throw a cushion. No form of insanity better illustrates the evolution of insane energy; from the pulse, the appearance, the feel of the muscles, one would expect collapse; and yet the violent exertions continue. Then comes exhaustion, and the patient lies prostrate, roused only by fugitive pains or hallucinations, stimulated by vigorous attempts at feeding or by the necessities of nursing, sleeping fitfully or not at all, rambling in a muttering fashion if her voice is not too hoarse and her mouth not too dry for articulation. It may be some days before this stage of prostration arrives, several days longer before recuperation begins, and it may be weeks before the patient is quiet and sensible; but the chances are that she will recover.

(*c*) *Insanity of Lactation.*—This form is commoner than the insanity of pregnancy, though it may be that the development of urgent symptoms has been postponed for months; and it is not so common as the insanity of the puerperium. It is an insanity of physical exhaustion, the result of continued depletion. It usually occurs in patients who have been suckling for more than six months. The typical variety is a slow melancholia with delusions, and with impulses often following obsession; but any grave occasion may determine an acute development either towards stupor or towards mania. Many cases are suicidal and many are infanticidal. From apathy about things in general the patient develops in the direction of neglect of her person, of the work of the household, and of the needs of her child. Her spirit is broken, her judgment lost, her self-control vanishing, and, if the disease be not arrested, she will suffer a deep melancholia, with gross delusions of a fearful kind and very dangerous impulses. I would draw attention to the physical state of these patients. It becomes a veritable cachexia. The pallid and perhaps icteric complexion, the sunken eyes and dilated pupils, the hollow cheeks, the wasted limbs and listless movements, suggest a pernicious anæmia, a diabetes, or an advanced phthisis. Yet in these cases, again, recovery is the rule.

It need hardly be said that departures from these types are very common. The last case that came under my observation was not at all like any of the varieties described. A young mother who had had a trying pregnancy, and who had suffered a severe shock towards the end of it, just succeeded in surviving puerperal delirium, but about the tenth day after delivery suffered a sudden impulse to injure her child with scissors, and then swooned. Thereafter she was beset for weeks with an obsession of blood; saw drops of it on every white surface she looked at, and, if her attention was not briskly employed, imagined patches or streams of it in front of her. She was separated from her child, carefully watched, generously fed, had tonics and open air exercise, and made an excellent recovery. She has had a second child without any untoward development. Such an exaggeration of the imaginative or delusional elements may occur in any of these insanities. Though melancholia is commoner, a pregnant insanity may go on to a deep stupor, or it may quite early develop into a mania. The same is true of lactational insanity, and especially of cases which occur in the early weeks, and which partake of the puerperal character. On the other hand, melancholia may persist as a sequel of puerperal mischief, or the patient may continue for weeks in a condition of mild mania characterised by delusions of grandeur.

3. Treatment, Management, and Prognosis.—These insanities are the most recoverable of all. The prognosis depends upon the heredity of the case, still more upon its history and especially upon the occurrence of previous attacks, most of all upon the management and treatment of the patient. But, in any case, 70 to 80 per cent of such cases recover. In the acute puerperal cases collapse and death are to be feared, while in the other varieties the fear is rather that the patient will live on into dementia.

As to treatment, I would emphasise the importance of prophylaxis; and that comes to be a question of the management of pregnancy and of the puerperium. I would remark that very few such good opportunities occur to the practitioner of earning the gratitude of his patient, as when he successfully pilots a tender woman of an insane predisposition through the physical and emotional distresses of child-bearing, and brings her safe into a sane motherhood. And I would submit, with deference, that both the general practitioner and the professed obstetrician might make more of such opportunities. It would be well if the practitioner, when he has booked a case for delivery at a specified date, when he has satisfied himself as to the pregnancy, when he has learned the history of previous confinements, if any, and when he has approximately gauged the diameters, it would be well if he would have minute regard to digestion and excretion in the case, to hygienic necessities, and would take reasonable precautions to preclude undue anxiety and worry. Morning sickness, for example, unless it actually threatens the patient's life, is still regarded as an incident hardly worth notice; constipation seems to be the rule; one rarely hears of the systematic dieting of pregnant women; and very few rules seem to be enjoined as to fresh air and exercise. Similarly, there is no instruction of the patient concerning the emotional and imaginative developments which she may expect; she is still allowed to believe that "maternal impressions" may have a serious effect upon her offspring; she is not warned that apprehensions and silly suspicions are sure to arise in her mind, and that she is to regard them as symptoms; and but little is done in the case of illegitimate pregnancies to moderate the rigours of a too severe public opinion. Prophylactic measures are especially called for in these days of city life. It might be an exaggeration to say that when a woman conceives she enters upon an abnormal state which requires a careful treatment, as if she had incurred a disease of nine months' inception; but it is true that, as women now live, pregnancy is a condition which calls for a most careful regulation and exercise of all the bodily functions, and a corresponding attention to mental hygiene. There ought to be, throughout the pregnancy of a nervous woman, a scrupulous care of diet, periodic investigation into the condition of the alimentary tract, the liver, the kidneys, and the skin, and a systematic mode of life prescribed, which will ensure much more than the usual amount of fresh air, and not much less than the usual amount of recuperative exercise. If these precautions be taken, and dangerous developments corrected, even unlikely cases would be safely got through. Moreover, it is only by some such method, approaching that of the paternal type of family doctor, that the signs of incipient mental derangement can be observed and a grave development obviated.

If insanity of a fairly pronounced type has occurred, the first questions are those of management—where to treat the case, and in what kind of general conditions. It goes without saying that the patient must be as healthily conditioned as possible, that she must have as good air and as good food as circumstances permit. But she must also be carefully guarded. If her symptoms are aggravated by the life of her home she must be removed, though preferably not to an asylum. In any case she must have constant companionship; and if at home, the companion must not be one who will excite her jealousy, either concerning her husband or, if she has any, her other children. She must have long hours of rest in bed in a very airy and bright room, and she should, unless local conditions forbid it, have exercise in the open air, bedroom gymnastics, or massage.

In the insanity of the puerperium, and in that of lactation, the patient should be separated from her child and from her husband. Many puerperal cases lend themselves to home treatment. The conditions to be treated are the pelvic, the disordered digestion, and the mental excitability. Vaginal douching and uterine douching, when necessary, should be made use of as freely as if the patient were not insane, and her tendency to misinterpret these measures should be ignored. The mouth should be kept clean by the use of mild scrubbing with medicated vaseline, or an antiseptic wash. Food can be administered by the tube, and a little patience and care will usually induce tolerance of it, so that even the stomach may be washed out without greatly disturbing the patient. For the muscular excitement I believe in physical restraint—the packing of the patient for periods when she is supposed to rest in blankets bound round her trunk and limbs, and enclosed in a mattress tied round with straps or sheets. As to sedatives, it is the opinion of most that their use is inadvisable; but that is probably because of the unsatisfactory result of continued doses of too small a quantity. Several hours of sleep may be obtained by the rectal injection of paraldehyde in brandy with warm oil. Begin with a usual dose, but repeat and increase it, after a few hours, if the symptoms are favourable, giving three or four drachms in half an ounce of brandy, along with the oil, or with soup, or peptonised jelly. Similarly, and as an alternative, if the stomach tolerates liquid feeding, give bromide in full doses, working up to a drachm every four hours before the patient acquires a tolerance of it. But do not continue the use of a sedative for more than thirty-six or forty-eight hours.

For the insanity of lactation the treatment, again, is towards correcting the physical factors—by weaning the child, and building up the depleted tissues—removing the patient from the home environment which has exhausted her, and making herself, her husband, and her child safe from her violent impulses.

V.—SARCOMA-DECIDUO-CELLULARE OR DECIDUOMA MALIGNUM

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On the 16th July 1888, at a meeting of the Leipzig Obstetrical Society, Professor Sänger made a communication upon "two uncommon cases of abortion"; one of these cases was the first recorded example of the disease which we have now to consider. Since then nearly 100 cases have been recorded and a considerable literature has accumulated, from which we have learned that this disease differs sufficiently from all others hitherto described to justify its separate consideration. Observers are almost unanimous as to its connection with pregnancy, its clinical features, pathological appearances, and appropriate treatment, but they differ in their views as to its histogenesis.

The case reported by Sänger was so typical of the entire group of recorded cases, that I think a *résumé* of it will serve as an introduction better than any mere definition.

The patient was a young married woman, aged twenty-three, who aborted at the eighth week in consequence of a fall from a railway carriage. The abortion was incomplete, and hæmorrhage continued for three weeks. In the fourth week the discharge became fœtid, and Sänger was called in. He found the patient very anæmic, with symptoms of septic absorption and putrefaction of the uterine contents. The uterus was thoroughly cleared out, hæmorrhage and discharge ceased, and the temperature became normal; the pulse, however, continued to be over 100, and recovery was so slow that she did not leave her bed for five months. Her protracted convalescence was attributed to a small exudation in the left parametrium. An enlargement of the uterus was also observed, but was supposed to be due to subinvolution. She had not long left her bed when she was obliged to return to it again in consequence of fever and pains in the right hypogastrium, where a tumour as large as a goose egg had formed in the neighbourhood of the iliac crest. It was soft and tender, and, being supposed to be an abscess, was incised, but no pus escaped. It consisted of a soft spongy substance, of which about a handful was removed, leaving a cavity at the bottom of which lay the bare and roughened bone. On microscopic examination this tissue showed large multinucleated round cells, with spindle cells and numerous apoplexies. Soon after this operation pulmonary symptoms set in, with cough and dyspnœa, and she died seven months from the commencement of her illness.

On post-mortem examination the uterus was found to be infested with dark purple-red spongy nodules varying in size from that of a walnut to that of a large apple. The mucous membrane was smooth and nowhere perforated by the growths; metastases were found in the iliac fossa, lungs, diaphragm, and ribs.

The left lung was compressed by a hæmatothorax; microscopic examination of the uterine tumours showed numerous apoplexies, large nucleated round cells, and cells resembling decidual giant cells, suggesting the idea that here was a new growth of the decidua belonging to the group sarcomata which had never before been described.

Clinical Features.—The clinical features of this disease are thus summed up by Sänger:—

1. A birth, abortion, or hydatidiform mole followed by—
2. Constant or repeated hæmorrhages.
3. After this, and generally following an examination or intra-uterine manipulation, putrid discharges with fever.
4. Increasing size and irregular shape of the uterus.
5. Rapidly progressing and towards the close intensely marked anæmia.
6. Recognisable metastases especially in the vagina.
7. Cough, dyspnœa, bloody expectoration, and other symptoms of pulmonary metastases and hæmatothorax.
8. Rapid course of the disease, which usually proves fatal within six or seven months.

The first point of importance is the connection of this disease with pregnancy; in almost all recorded cases it has come on after an abortion hydatidiform mole, or very rarely after delivery at term. In about half the cases it has followed the expulsion of a hydatidiform mole—a remarkable fact of much importance with regard to its etiology. The second point is hæmorrhage, which either continues after the expulsion of the ovum or commences shortly afterwards. In a few cases it did not occur for a considerable time, and in one recorded by Whitridge Williams it was altogether absent, the first evidence of the disease being metastatic deposits in the vagina and lungs. In the majority of cases, however, it is the most prominent symptom, so that the patient soon becomes profoundly anæmic. The surface is pale, and in places slightly œdematous; the face especially assumes a pallid, icteric, cachectic appearance.

When the tumour sloughs the discharge becomes offensive and septic fever sets in. It is, therefore, of the utmost importance to observe the strictest antiseptic precautions in dealing with these cases.

On physical examination the uterus is found enlarged, often irregular in shape, and in some cases the os is sufficiently dilated to admit a finger, in which case the growth may be directly felt.

The course of the disease is one of marked malignancy; in fact, it is the most rapidly fatal of all malignant uterine growths, death occurring from hæmorrhage, septic infection, or pulmonary complications within a few weeks, rarely months, after the first symptoms have been observed.

Pathological Anatomy.—The uterus is usually found infested with new growths, varying in size and colour, but generally of a dark purple-red. They involve the muscular tissue of the uterus, so the peripheral margin is ill defined, and after removal the uterine wall appears thinned. The growth is soft and, where not coloured with blood, of a greyish-red hue; it closely resembles placental tissue in its irregular fissured surface, its fibrous appearance on section, extreme vascularity and numerous apoplexies, but it is much softer and more friable, and its uterine surface shows a remarkable tendency to slough.

Microscopically these growths are composed of a fibrous reticulum presenting an alveolar and cavernous structure containing numerous apoplexies, two varieties of cellular elements, and sometimes chorionic villi, but no glands, blood-vessels, or lymphatics. The two varieties of cells contrast remarkably. The one are large individual cells varying from round or polygonal to spindle shape, the nuclei are large, and the outline of their cell protoplasm is clearly defined; they resemble Langhans' cells. The others are protoplasmic masses of various shape which contain a number of irregularly shaped nuclei rich in chromatin, but with no line of separation between the cells, and resemble the syncytial layer which forms the superficial covering of the chorionic villi. Both varieties of elements show a marked tendency to retraction of their protoplasm and vacuolation; mitotic figures are frequently observed in the cells, but nowhere in the protoplasmic masses.

Metastases are generally found in the vagina, lungs, and other parts, and, as a rule, present the same appearances as the primary disease; but Pick and Schmorl have shown that metastatic growths are not always malignant, and also that there have been cases in which typical chorio-epitheliomatous growths have been found in the vagina, lungs, liver, and other places, causing the death of the patient, and yet no primary uterine growths could be discovered (Schmorl, Schlagenhaufer, Schmidt).

Metastases in connection with such a malignant disease of the uterus is easily understood, but the occurrence of chorio-epitheliomatous growths in the vagina and elsewhere with a healthy uterus is not so readily explained. Schmorl, Kossman, and J. Nusmann supposed that there must have been a primary malignant disease of the ovum which caused metastases, and was subsequently expelled without infecting the uterus, but Pick and Gottschalk considered this most unlikely, and thought that more probably the metastases were originally of a benign nature, but afterwards underwent malignant degeneration. Schmidt considers that this hypothesis is borne out by the length of time that intervened between delivery and the appearance of the vaginal growths, viz. in Schmorl's case, eighteen weeks after delivery at term—in Schlagenhaufer's, nine months after an incomplete abortion—and in his own case, three months after expulsion of a hydatidiform mole.

Diagnosis.—An early diagnosis is of vital importance, and fortunately it is not difficult provided careful clinical and microscopic attention be devoted to it. When hæmorrhage occurs after an abortion or molar pregnancy the uterus should always be thoroughly evacuated by the finger and curette, so that one can be certain that everything has been removed and a smooth surface left. If after this hæmorrhage recurs, and a second evacuation reveals a quantity of soft friable tissue, the case is certainly not one of simple abortion, and is in all probability one of deciduoma; one must, however, be certain that the first curetting was thorough and complete. The size and shape of the uterus varies, but is never below the normal, and enlargement of the organ after discharge of the ovum is of much diagnostic value. The os is often sufficiently open to admit the finger, but may require artificial dilatation. Soft masses of friable material resembling placenta are then discovered, and portions removed by the curette should always be submitted to microscopic examination.

Treatment.—Total extirpation is the only method of treatment which has hitherto yielded any benefit, and it is of the utmost importance that this operation should be performed at the earliest possible time before the patient has become exhausted by hæmorrhage, and before putrefaction sets in or metastases have occurred. It must not, however, be regarded as hopeless, even under such unfavourable conditions, for cases have been reported by Chrobak and Von Franke, where in spite of evidences of pulmonary embolima, as shown by bloody expectoration and other symptoms, recovery has followed operation. Lönnberg-Mannheimer saw numerous metastases in the cervix, introitus vaginæ, and vagina, yet the patient had no return for eighteen months after operation. Cazin found a metastasis in the ovary; three years after the operation she was well. Schauta extirpated a metastatic growth from the vagina along with the uterus; at the time of publication there had been no return. Schlagenhaufer and Schmidt have reported cures after the extirpation of vaginal growths only—the healthy uterus being left.

Histogenesis.—According to most observers, this disease is always connected with and is probably due to pregnancy. The only dissentients from this view were Drs. Eden and Kanthack, who stated at the meeting of the London Obstetrical Society, in the discussion on Dr. Herbert Spencer's case, that the microscopic appearances were in no way peculiar, but similar to those found in sarcomata in other places, and that in some of the cases pregnancy was doubtful. In the discussion which followed Dr. Haultain's communication to the British Gynæcological Society, however, Dr. Eden stated that he was personally in full agreement with the views of J. Veit in the *Handbuch der Gynaekologie* that the disease was a sarcoma modified by the occurrence of pregnancy. We may, therefore, assume as generally accepted that the disease is in some way due to pregnancy. In order to understand the conflicting views as to its origin we must briefly recall the normal condition of the tissues which it affects. The placental villi consist of a stroma covered by two layers of epithelium, an inner called Langhans' layer, composed of individual cells with a distinct cell wall, and an outer formed of protoplasmic masses without any line of demarcation, termed the syncytium. These villi penetrate the decidua serotina and maternal blood-vessels forming the placenta.

Now the disease which we are considering has been supposed by different observers to originate from each of these structures, and hence the varying nomenclature. Thus Sänger believes that it originated in the decidua, and he gave it at first the name of deciduoma malignum, but subsequently he preferred to call it sarcoma-deciduo-cellulare, because he believed that it originated in the cellular layer of that membrane after it had been altered by pregnancy. Gottschalk believed that it originated in a case described by him in the stroma of the villi. Marchand, Gebhard, and Haultain attributed its origin to the epithelium covering the villi, and Whitridge Williams to the outer layer or syncytium only, and termed it carcinoma syncytiale, chorion epithelioma, or blastoma-deciduo-chorion-cellulare.

These authorities may, therefore, be divided into those who hold that the disease is a sarcoma and those who regard it as a carcinoma. Sänger regarded it as a sarcoma of the cellular layer of the decidua because of the similarity of structure in both, the size and shape of the cells, and the presence of a reticulum, the only difference being that in the pathological cells the nuclei were larger and the surrounding protoplasmic ring narrower. He rejected Veit's theory that the disease was due to the modification of a pre-existing sarcoma, because no case had been recorded of the implantation of an ovum upon a sarcomatous or carcinomatous endometrium; and he believed that his claim to the growth being different from all others hitherto described, stood or fell with its origin during pregnancy. Veit, however, in the newly published *Handbuch der Gynaekologie* still maintains that the sarcoma precedes the pregnancy and is modified by it. He admits that no case has been recorded of the implantation of an ovum upon a carcinomatous endometrium, but in nodular sarcoma the membrane resembles that in myomatous uteri; and that as pregnancy occurs in the one, so it may also in the other. He considers that it is impossible to regard all the protoplasmic masses as true syncytium derived from the outer layer of the villi, but rather, as it has been shown, that in normal pregnancy other cells, such as the epithelium of the lining membrane of the uterus, and especially of its glands, often take on a syncytial form, and therefore syncytium in the wider sense cannot be regarded as a distinct tissue, but as a stage in the development of certain cells. So a sarcoma may under the influence of pregnancy come to resemble syncytium; and since fœtal elements are not always found in these cases, they cannot be regarded as the chief characteristic; but as masses resembling syncytium are the rule, the disease should be regarded as a process in which under the influence of pregnancy certain cells take on a syncytial character. Hydatidiform moles so frequently associated with deciduoma are not the cause but the result of uterine disease; and regarding deciduoma in a similar manner, the primary disease is to be sought for in the uterus.

In fibro-sarcomata the uterine mucous membrane is in a condition resembling that in myomata, in which pregnancy often occurs, and so it may in sarcomata; but under the influence of pregnancy the growth undergoes changes, and its cells assume a syncytial character. Under the influence of the growth, pregnancy may be disturbed or ended, a hydatidiform mole develop, or it may go to term. At the birth the entire ovum may be expelled, or a villus or villous epithelium retained grow into the veins and be carried into the circulation, causing metastases; in either case the tumour goes on growing and leads to a fatal termination. The disease remains the same, whether it does or does not contain fœtal elements, the latter being accidental. The essentials are the original uterine disease and the occurrence of pregnancy, under the influence of which the syncytial changes in the growth occur.

Gottschalk, in 1892, described a case in which the stroma of the villi was changed into a structure formed entirely of large polymorphous cells, whose epithelial covering showed a remarkable proliferation; he regarded the disease as a sarcoma, and believed that it originated in the stroma of the villi. This case was the first in which the disease was diagnosed and the uterus extirpated during the patient's life.

The majority of pathologists regard this disease as of epithelial origin, and therefore a carcinoma; foremost amongst whom is Marchand, whose writings have done much to elucidate its pathology, and especially its connection with hydatidiform mole. In an elaborate paper, beautifully illustrated, which he read before the British Gynæcological Society in June 1899, Dr. Haultain warmly advocated Marchand's views, and stated that the chain of evidence in favour of this new growth being of epithelial origin had to his mind no weak link. The structural appearances, the physiological prototype of the young villi, and the interesting association with myxoma of the chorion which it closely resembles anatomically, physiologically, and pathologically, all serve to prove that it is of epithelial origin.

It would be impossible in the present state of our knowledge to say which of these views is the correct one.

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Introductory.—The older physicians placed great reliance upon the sensation communicated to the finger by the pulse. The Arabian and Moorish physicians recognised its importance, and our Celestial brethren pretended to be able to distinguish upwards of three thousand varieties of pulse. The Chinese even professed their ability to distinguish the sex of the fœtus *in utero* by feeling the pulse of the mother.

Before the introduction of the clinical thermometer the value of the pulse in diagnosis and prognosis was fully appreciated, and at the present day its examination is even more instructive, because the information obtained can often be usefully compared with the temperature.

In the present article it is proposed to consider some aspects of the subject which may prove of interest and value to the general practitioner.

It is a good rule to always make a point of feeling both radial pulses. The superficialis volæ branch may sometimes become the main trunk of the radial artery, and then the greatest pulsation will be found over the dorsal aspect of the thumb. When this abnormality exists there is a very feeble pulse in the usual situation, and this may mislead the unwary. A real difference in the radial pulse of the two sides may suggest the presence of an aneurysm or intra-thoracic tumour.

The Examination of the Pulse by the Finger.—There are a number of characters in the pulse which can be appreciated quite well without apparatus—others require instrumental investigation. When the radial pulse is felt, the physician first of all takes note of its *frequency*. But its *character* is of much greater significance. Thus the finger must try to gauge the volume of each pulse wave, whether it is *large* or *small*, and it is also important to form an impression as to the manner in which the artery is filled by the ventricular systole, whether *quickly* or *slowly*, and how the vessel wall collapses after impinging against the finger. In addition, an estimate should be made of the *compressibility* of the pulse beneath the finger—whether it is soft or hard.

The *rhythm* of the pulse must always be noted, whether it is regular or irregular, and also the *character of the arterial walls,* whether they are thickened, atheromatous, or unduly contracted.

FREQUENCY OF THE PULSE

The frequency of the pulse may be affected by many conditions which, either directly or indirectly, act upon the heart. To refer briefly to the *direct* causes which may influence the heart's action, mention may be made of the state of distension of the ventricles. If the heart is well filled it contracts better, though this is also determined partly by the state of the arterial resistance ahead. The frequency of the heart-beat is closely related to the condition of the arteries—dilatation of the vessels causes quickening of the heart, while their contraction may lead to marked slowing.

The rate of the beat is also affected in a striking manner—increased or slowed—by the character and quantity of the blood supplied to the heart muscle through the coronary arteries. It is highly important to bear this in mind, for the myocardium may suffer both from the effects of various toxins carried to it in the blood current, and also from a simple deficiency of blood. As is well known, the heart muscle may be profoundly affected by the toxins of many of the specific fevers, by anæmia, Bright's disease, gout, plumbism, alcohol, etc.; and, in pneumonia, muscle failure of the heart may result from the greatly lowered blood pressure, which interferes with the adequate blood supply to the cardiac walls through the coronary arteries.

Temperature may directly affect the heart's action. A poultice applied to the precordial region quickens the beat; an ice-bag slows it. The heart may, in a similar manner, be directly accelerated by the presence of hot liquids in the stomach, and also, perhaps, from direct pressure due to a distended stomach.

Lastly, among direct causes are the influences exerted over the heart by the vagus and sympathetic nerves.

There are a large number of *indirect* causes which affect the frequency of the pulse.[1]

Muscular exercise is one of the most conspicuous causes of increased pulse frequency. In some people the frequency may increase by 50 beats per minute with the exertion of running to catch a train. Violent dumb-bell exercise will produce the same result. The pulse-rate quickly returns to the normal in healthy persons after exercise, unless the active movements have been long continued.

The taking of food and drink—apart from stimulants—accelerates the pulse. Hot water, or more especially hot whisky-and-water, quickens the pulse, but a large draught of any cold liquid may slow it. It is interesting to note that quite apart from the taking of food and drink, the movements of mastication, sucking, and swallowing produce a marked increase in the pulse-rate. Kronecker has shown that the act of swallowing seems to remove entirely the inhibitory action of the vagus upon the heart for the time being, and, according to Brunton, a glass of water slowly sipped may quicken the pulse-rate from 68 to 92 beats per minute.

Mental conditions and various emotional states affect the pulse-rate very considerably, either temporarily, *e.g.* when a healthy individual is being examined for life insurance, or more permanently, in persons who have sustained some severe shock to the nervous system, as from fright or grief.

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[1] For a full and connected account of the pulse as it is affected by age, sex, posture, exercise, food, and other natural causes, the reader is referred to an article by Dr. Guy in Todd's *Cyclopædia of Anatomy and Physiology*, vol. iv., 1847-49.

The temperature of the skin indirectly modifies the pulse frequency in a reflex manner. The left ventricle responds very precisely to the call of the peripheral tissues for more blood. Thus in a heated room the peripheral vessels dilate, and the ventricle responds by beating more quickly; if they contract, as happens in a cold atmosphere, the heart-beat becomes less frequent. Clothing, by supplying warmth, increases the rate of the pulse; exposure of the naked body to the cold air slows it. The pulse-rate is found to increase in tropical climates, and is diminished in the Arctic regions.

The position of the body is an important matter with regard to pulse frequency. In recumbency the rate may become much slower than normal, and when a child is kept in bed for a considerable period the pulse may become remarkably slow and irregular. The same condition is found in children during sleep. The heart-beat varies a good deal according to the time of day. Its action is slowest very early in the morning, between two and four o'clock—this is the time when all the vital functions are at their lowest. It rises up to its maximum about ten or eleven in the morning, then comes down, but rises again between two and three o'clock in the afternoon, then keeps steadily going down again. This is the regular rhythmic way of the heart.

Change of position of the body—*e.g.* from the sitting to the erect posture—markedly affects the pulse-rate even in healthy persons, but the effect is not the same at all periods of the day. The greatest average difference occurs before noon. An increase of not more than 5 to 10 beats per minute is normal, and may be taken as evidence that the heart muscle is in good condition, and that it is capable of responding adequately to a call for increased work should it be demanded. Many conditions, however, may lead to a contraction of what Mackenzie has called the "field of response" of the heart, and then the change of frequency between the sitting and erect positions may reach 30 to 50 beats per minute. In people of nervous temperament, and particularly in women, the pulse-beat may become exceedingly rapid on the slightest emotion or exertion. But for the same frequency of pulse, the effect of change of posture in the male is more than twice as great as in the female. The difference is still more strongly marked in early youth. During pregnancy the tendency to abnormally rapid action of the heart on change of posture, or with moderate exercise, is sometimes very evident, and would seem to indicate that if true hypertrophy of the heart has occurred it is certainly not of a compensatory nature (Figs. 1 and 2). This condition is usually a temporary one, but sometimes, after several pregnancies in rapid succession, the heart may be left with a permanently contracted field of response.

Pyrexia tends to neutralise, and debility to exaggerate, this postural variation in the pulse-rate.

Age may be added as a cause which influences the frequency of the pulse. Thus during the first few weeks of life a pulse-rate varying from 120 to 150 may be regarded as normal. At this age posture seems to have little effect in modifying the rate. During the second year of life the rapidity of the pulse falls from 120 to 100 beats per minute. From the third year to puberty there is still a notable diminution in the pulse-rate, and after that it remains pretty constant till the age of sixty is reached. Then a quickening may commence which is often proportionate to the degree of arterial degeneration, and which depends also on the condition of the myocardium.

The pulse frequency varies with the sex of the individual, and is greater in women than in men. Still, a tall woman may have a slower pulse than a small man—the larger the frame the slower the pulse as a rule. The normal frequency in healthy people may vary very greatly, and constant rates of 40 and 100 have been noted in people apparently free from disease.

Significance of Frequency of the Pulse.—Mere frequency of the pulse, without regard to the state of the temperature or respiration, may have great significance, if it is constantly beyond what one recognises as normal. In uncompensated valvular disease the pulse is abnormally rapid even when the patient is recumbent. This is also the case in all forms of myocarditis, especially where the heart muscle has suffered from excess of alcohol, or from other toxic influences. The same condition of matters may follow overstrain, *e.g.* the "soldier's heart," and the so-called irritable heart. In neurasthenia, both in men and women, the pulse is sometimes persistently rapid, and is almost always very soft. In exophthalmic goitre the remarkable dilatation of the arterioles all over the body leads to greatly diminished peripheral resistance, and this may partly explain the abnormally rapid heart-beat. In puerperal insanity there may be much prognostic significance in the pulse-rate alone. Should a woman become maniacal a few days after delivery, without the pulse being greatly increased in frequency, there is little or no danger to her life, although she may lose her reason. A pulse of 120 to 150 at the onset of any form of puerperal mania is of almost invariably fatal significance.

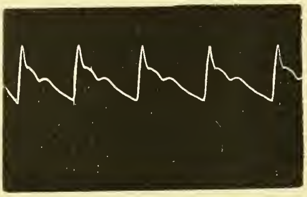

Fig. 1.—Tracing of the radial pulse from a healthy young primipara, 7½ months pregnant, in the sitting position.

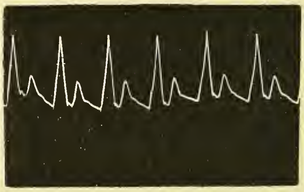

Fig. 2.—Tracing of the same pulse shortly after assuming the standing position. Shows increased rate of pulse and fall of blood pressure.

A pulse ranging above 110, in a person older than twenty-five years, of the male sex, and not of nervous temperament, is, according to Copland, not without risk; the amount of risk will depend on concomitant circumstances. A pulse which is constantly of this rate may, under these conditions, be suggestive of latent tuberculosis.

Unusual slowness of the pulse may also attract attention to some morbid condition. A pulse of 50 or 60 or less may be normal to certain persons, and sometimes this feature belongs to several members of a family. The normal slow pulse is generally associated with a high arterial blood pressure, and the gouty diathesis may be the underlying cause. Those who are subject to gout, however, may have a pulse of high frequency.

Pressure on the brain may cause remarkable slowing of the pulse, especially when it affects the basal portions. Intense pain, *e.g.* that due to gall-stones, will often slow the pulse, and the blood pressure may be raised temporarily. Stokes has noted that in some cases of pericarditis the frequency of the pulse is diminished at the commencement of the disease. Structural lesions of the heart—fatty heart—may also give rise to very extreme states of slowness. Then there are many toxæmic conditions which lead to a slowing of the pulse-rate. On the invasion of certain specific fevers, and sometimes also before death in these cases, the pulse may become greatly diminished in frequency. In Bright's disease the increased arterial pressure, which is excited by toxic influence, generally retards the heart's action; and in jaundice marked slowing of the pulse may occur. In children suffering from simple catarrhal jaundice, however, the pulse-rate does not often seem to be affected in this way. During pregnancy there may sometimes be a slowing of the pulse in the recumbent posture, but the acceleration caused by assuming the erect position is greater than it is under normal conditions. There is a toxæmia in pregnancy, and the *rate* of the pulse, in the sense that it reflects, more or less, the state of the blood pressure, is of some value as a symptom. The writer has made some observations on this matter, and believes that it is unusual to find either marked slowing of the pulse, or even much increase in arterial blood pressure, during the course of normal pregnancy. One might go the length of saying that the appearance of a strikingly *slow* pulse towards the end of gestation, if it persists for any length of time, forebodes danger. Examination of the urine may show that it is both scanty and albuminous, but the abnormal slowness of the pulse may precede the changes in the urine. For several weeks before the onset of eclampsia this pulse feature may be the only noteworthy symptom.

After the completion of the third stage of labour there is generally a marked fall in pulse-rate. The pulse may then become slower than that which is normal to the individual.

The pulse in children and also in young adults during convalescence from acute disease generally becomes very slow, and the individual beats are of unequal duration. The peculiar halting character of this slow pulse is perhaps specially well developed after the subsidence of the fever in cases of acute nephritis. It is also strikingly noticeable some days after the crisis of acute pneumonia, and may be regarded as a characteristic post-febrile feature of the pulse in children. In children who are apparently convalescent from diphtheria the pulse may sometimes become excessively slow and feeble, and heart failure from paralysis of the organ may then be imminent. Weber states that the pulse may fall to 28 beats per minute or even lower in these cases. In sclerema of the new-born infant the pulse may fall as low as 60 per minute.

Significance of the Pulse-rate when in Contradiction to the Temperature or Respiration.—It is always well to make a comparison of the pulse-frequency with the temperature chart, as this will sometimes lead to important conclusions. The significance of an elevated temperature without a corresponding increase in pulse-rate is of varied importance. In enteric fever the pulse is commonly between 80 and 100, when the temperature is considerably raised. This is to be regarded as a favourable sign. It is probable that a special toxic substance circulating in the blood is responsible for the relative slowness of the heart, and the combination is sometimes suggestive from a diagnostic point of view. In the early stages of influenza the same thing may be observed, and is of little moment, but occurring in the later stages it is a symptom of bad omen. In rheumatic fever it sometimes happens that a rapidly increasing temperature is not accompanied by a corresponding quickening of the pulse, and there may be delirium. Such a condition of matters would lead one to give a prognosis of the utmost gravity. Mention may here be made of a special circulatory feature in yellow fever, where there is a slowing of the pulse with a steady or even rising temperature. This peculiarity is believed to be of some value in the diagnosis of the disease, but seems to have no special prognostic import. In cases of cerebral compression from any cause, *e.g.* tubercular meningitis, the pulse is often unusually slow, and also irregular in rhythm. In cases of intracranial tumour and tubercular meningitis the mere slowness has little diagnostic importance—the chief significance lies in the fact that this feature co-exists with marked elevation of the temperature. The contracted condition of the radial artery is a point of great importance in these cases.

While discussing the value of pulse symptoms, brief reference may be made to some of the conditions in which the pulse-rate is greatly accelerated without a corresponding rise of temperature.

Thus, at the commencement of scarlet fever a pulse of 140 to 150 may be found when the other symptoms are insignificant. This is always suggestive, for the toxin of the disease, in striking contrast to that of enteric fever, leads to a great acceleration of the heart-beat. The extraordinary acceleration of the pulse towards the close of tubercular meningitis is also noteworthy. In acute pneumonia an extremely rapid pulse at the onset, especially if it be notably soft, is almost always a fatal sign, even though the extent of lung involved is not large. It may indicate that the cardiac muscle has been completely disabled by the initial virulence of the toxin. When the pulse persistently increases in rate and becomes softer towards the end of the disease, the prognosis is invariably bad. In pulmonary phthisis, without marked pyrexia, a persistently rapid pulse is of serious import. In acute rheumatism a pulse of 120, without cardiac complications, signifies danger, whereas if pericarditis be present the pulse-rate may reach 150 per minute without serious results.

Every careful physician, if only for his own peace of mind, keeps an anxious watch upon the frequency of the pulse during the puerperium. At this time an increasing pulse-rate always excites greater concern than a rising temperature, and may be the precursor of septic infection. A high temperature during the puerperium need cause little anxiety unless the pulse becomes extremely soft and rapid.

After severe hæmorrhage—post-partum, from gastric or duodenal ulcer, etc.—the pulse-rate becomes greatly increased. But after forty-eight hours, or less, if considerable slowing has not occurred, the outlook is uniformly bad. The same remark applies to the frequency of the pulse after abdominal injuries and operations—a falling pulse-rate is always necessary to justify a favourable prognosis, even though the temperature is subnormal.

To sum up, then, it may be said that while undue slowing or great rapidity of the pulse may not, in themselves, suggest danger, still when viewed in conjunction with the temperature chart some significance is at times attachable. But the character of the pulse must always be taken into account. If it becomes more rapid and at the same time softer, it is a sign of approaching death.

The ratio of the pulse-rate to the respiration is sometimes suggestive. In pneumonia, according to the acuteness of the case, the pulse respiration ratio is greatly altered, and in some cases of catarrhal pneumonia in children the ratio may be 1 to 2, or even 1 to 1·5. Notable perversion of the pulse respiration ratio may be observed in some cases of fatty heart, where a pulse of 40 may co-exist with a respiration of twenty per minute, or a ratio of 2 : 1. In severe cases of rheumatic pericarditis, according to Walshe, the respiration rate may be greatly accelerated even though there be no pulmonary complication. Thus the pulse respiration ratio may be 136 : 64, or 2·12 : 1.

Definition of the Pulse

The pulse consists in the sensation imparted to the finger when it is made to compress an artery.

It is necessary to discuss this definition in some detail, so as to clearly understand the nature of the pulse sensation.

The pulse-wave in the arterial system depends on the heart's action—on the left ventricle throwing a quantity of blood into the aorta. Briefly, we may put it in this way. Just before the aortic valves open, the pressure of blood in the left ventricle is the same as that in the aorta. After the aortic valves open, the pressure in the aorta gets increased by the systole of the ventricle, which adds several ounces to the bulk of blood already in it. This addition to the aortic contents leads to an *increased pressure* within the whole arterial tube. The radial artery, flattened under the finger or by the pad of the sphygmograph during the diastole of the heart, alters its shape under the distending force of the extra blood thrown into it by the ventricular systole. The pulse is therefore, essentially, the expression of *increased blood pressure.* By flattening the artery somewhat at a time when the resistance to compression is at its lowest, one more readily appreciates the change to the condition where the resistance to compression is at its highest. We purposely flatten the vessel against the underlying bone in order to observe this change of form, because it is then possible to appreciate the pulsation more efficiently. This is not essential, however, for the mere perception of the beat; for sometimes the pulse can be counted by simple contact with the finger.

In order to form a clear idea of what really constitutes the pulse, the writer knows of no more useful simile than that suggested by Sir William Broadbent. He says, "Such a pulsation can be felt on a large scale by placing the foot on the unyielding and inelastic leather hose of a fire-engine in action." The comparison is an excellent one, and it serves to contradict the impression that the pulse is due mainly to an *expansion* of the artery. The extra quantity of blood pumped into the aorta at the systole of the ventricle simply distends some of the larger vessels—any expansion of the smaller arteries is quite insignificant.

Again, the pulse, as it is felt in any superficial artery, *e.g.* the radial, is not due to the blood pumped into the aorta which has passed down there, but it is a wave, originated by the impulse of the left ventricle, that has travelled along the particles of fluid in the artery. This pulse-wave, as it may be called, travels at a rate of 28 to 30 feet per second, while the rate of movement of the blood is only about 10 to 12 inches per second.

When a ligature is put upon an artery no pulse is felt beyond that point, but it is distinct up to the place where the artery is obstructed. This experiment enables one to appreciate the dependence of the pulse on the systole of the ventricle alone, when onward movement of the blood is prevented. The pulse is nothing else than the beats of the heart transmitted through the arteries.

Factors of the Pulse

The main factors concerned in the production of the pulse are:—

(1) The contraction of the left ventricle.
(2) The elasticity of the arterial walls.
(3) The resistance in the arterioles.

The character of the pulse may be influenced largely by the *left ventricle* in many ways. Roy and Adami consider that *the mode of contraction* of the left ventricle is a more important factor in the production of the different varieties of the pulse than the condition of the arterioles. The character of the systolic contraction depends partly upon the condition of the cardiac walls, but it is also controlled in an important manner by means of nerves. The regulating influences of the vagus and accelerator must not be forgotten in this connection, and the intrinsic ganglia are equally important. Thus we may include the *nerves* of the heart among the factors of the pulse, and we find certain types of pulse irregularity which are due entirely to their effects.

The *state of the arterial walls* will clearly affect the character of the pulse, and this is important both with regard to degenerative or hypertrophic changes and also in relation to the condition of spasm, which may be excited by the abnormal contents of the vessels. Various states of toxæmia may induce this temporary condition of arterial spasm, which is accompanied by a general diminution in the calibre of the arteries during the time that the toxic substance is exerting its effects. Coincidently there is a marked alteration in the pulse. Among the factors of the pulse, then, we may also include the *blood.* Its impaired quality will lead to conditions of arterial spasm; and, if the toxæmia be long enough continued, a permanent alteration may be produced in the walls of the arteries.

The elasticity of the large arteries is a factor upon which the character of the pulse largely depends. By virtue of their elasticity the arteries always exert some compression on their contents, and this is so even during the diastole of the ventricles. At each systole some distension of the larger vessels occurs, and thus the force of the heart is, so to speak, stored up, and its energy is gradually, instead of quickly, expended. It is otherwise when the vessels have become rigid from disease, whereby the functions of their elastic coats are seriously impaired. Thus the factors concerned in the production of the pulse in the child and in the old man respectively differ greatly, and for this reason one cannot compare the characters of the pulse at these periods of life. The inelastic artery of old age has a limited capacity of storing up the force of the left ventricle.

The state of the *arterioles* with regard to their permeability to the flow of blood must, of course, affect the character of the pulse by determining the rapidity of the outflow of blood from the larger arterial tubes. We also recognise that certain sections of the arteriole field may contract or dilate from various causes, and we must not forget that the vessels of the splanchnic area, by becoming fully dilated, may empty the arterial system and thus give rise to a pulse of extremely small volume at the wrist.

Therefore we cannot draw reliable deductions from the *volume* of a pulse, unless we take the condition of the other factors concerned fully into consideration.

Shortly before death, more especially in cases where the cardiac muscle is in good condition, one is repeatedly struck with the large volume, and sometimes with the good pressure, of the pulse. Such a pulse may mislead us as to the fatal issue. An abnormally relaxed state of the arteries along with a feeble left ventricle will give the same kind of impression to the finger as that given by a strong ventricle acting against a normal peripheral resistance. If the blood pressure be fairly good, we must remember that the dying heart is working at its highest pressure, while that of the strong healthy individual has a considerable reserve power to fall back upon. In some instances the blood pressure maintained by the heart shortly before death may be said to be relatively high.

Examination of the Pulse by Means of the Sphygmograph

The only accurate method of recording the pulse is by means of the sphygmograph. Space will not allow of a description of the different forms of sphygmograph, and for a concise statement of these the reader is referred to Dudgeon's excellent treatise. Sphygmography has been in turn recklessly extolled and unduly depreciated. Those who assert that the sphygmograph is devoid of practical usefulness, and that it can be made to register any form of pulse-curve suitable to the occasion, simply exhibit their entire want of knowledge as to how the instrument should be employed. Such opinions belong to those who are either devoid of all mechanical skill, or to those who have not shown sufficient perseverance in mastering certain important details which can only be acquired after fairly long experience. With more perfect instruments the tracings would be more reliable, and probably a more skilled interpretation of the results is desirable. But the writer is convinced that much more can be learnt by the use of the sphygmograph than is generally believed. While the character of the pulse alone is not a safe guide to enable one to form conclusions in certain diseased conditions, still it will often afford indications of the utmost value bearing upon prognosis and treatment.

Dudgeon's sphygmograph is the one most in use in this country, and it is the only one which can be satisfactorily used in young children. If it be applied in the manner about to be described, most admirable and useful tracings can be obtained. The instrument must be a thoroughly good one; and I give this caution, because several which I have examined are of inferior workmanship, and quite unsuited for the purpose. The writing needle, which should be finely pointed, must swing evenly and easily, and the inelastic strap which fixes the instrument to the wrist must be replaced by pieces of elastic band. This simple modification immensely simplifies the process of obtaining successful tracings, for the instrument is very readily applied by tying the two pieces of elastic, and the button can then be adjusted over the artery to a nicety.

Both practice and judgment are necessary to enable one to apply just the requisite degree of pressure to the spring of the sphygmograph to obtain a maximal swing of the needle, for if the pressure be too great the tracing will not be a reliable one. The pressure is applied to the artery after the instrument has been tied on to the wrist; and by watching the movement of the needle, one is able, after some experience, to judge when the swing appears to be greatest, and whether the button is lying accurately over the vessel. It is impossible to gauge the amount of pressure exerted by the button of the sphygmograph on the underlying artery and the tissues surrounding it, but this is not essential for our purpose. When the swing of the needle is maximal, it shows that the pressure which we have applied to the artery by means of the screw is the proper amount for the case under examination. We do not expect the reading on the dial to give any indication of the actual blood pressure.

But here it may be said, that after some experience in the use of the instrument, it is sometimes possible to judge in a general way of the blood pressure by observing the manner in which the writing needle responds to the turning of the screw. Thus, in recording a pulse where the blood pressure is undoubtedly high—*e.g.* acute nephritis—the needle will not begin to swing freely until considerable pressure is made on the spring by turning the screw to three or four ounces on the dial, and then the maximal swing may be obtained over a considerable range of pressure. Again, in a markedly soft pulse a good swing of the needle may be obtained after a very slight turn of the screw, and its excursion will noticeably diminish when too great pressure is applied in this way.

The pressure applied to the artery by the spring of the sphygmograph, in taking tracings from children under a year of age, need seldom exceed two ounces, and in new-born infants the index must often register the smallest possible degree of pressure, as even this is sometimes too great for the strength of the pulse-wave, and an incorrect tracing is obtained.

To get the best results, even the smoking of the papers is a matter of some importance, for if they are smoked too thickly the smaller elevations in the sphygmogram will not come out distinctly. They should be put into the tin holder and smoked lightly and evenly over a piece of burning camphor or an untrimmed oil-lamp.[1]

The writer may here draw attention to a small time-marker which he has attached to the Dudgeon's sphygmograph. A record of time is sometimes very important, and it is inadvisable to add anything to the bulk of the instrument if it can be avoided, especially when it is to be used in children. Von Jacquet's sphygmograph has a separate clockwork box to drive the time-marker, and it is a large heavy instrument. In the writer's arrangement the chronograph is worked from the large cog-wheel of the mechanism which drives the paper roller, and each tooth of the cog-wheel makes a division in the tracing which is approximately equal to one-fifth of a second.[2]

It is important to wind up the clockwork after each tracing is made, and also to make sure that the paper is being driven at a uniform speed.

The Arterial Blood Pressure

Definition.—The vascular system is over-filled, for were it not distended it could not contain all the blood. Thus the blood is lying in the vessels at some pressure, as is seen by the spurt which occurs when an artery is cut. The heart—one of the factors in the blood pressure—keeps up the over-filling of the vessels, and the resistance to the outflow of blood through the arterioles and capillaries determines the extent to which this over-filling occurs.

When an artery is compressed by the finger the state of distension of the vessel is appreciated; the *resistance to compression*, therefore, represents the blood pressure, and the *height* of the arterial pressure is determined largely by the ease with which the arterial over-filling is run off by the capillaries, that is, by the peripheral resistance. This is the other main factor in the blood pressure, and any variation in one or other of these factors may alter the pressure very considerably.

Relation to Ventricular Contraction.—The relation of increased heart force to blood pressure is not a simple one. When the ventricle contracts more powerfully the pressure is not always increased, for the heart's beat is always maximum; that is to say, the ventricles cannot, by contracting more forcibly, pump out more blood than they get from the auricles. The action of the auricles—"the feed-pumps of the ventricles"—is also important in relation to blood pressure, and great alterations may be produced by changes affecting the auricles alone. Increased work of the heart, however, without a coincident dilatation of the peripheral vessels, leads to a higher blood pressure.

Relation to Peripheral Resistance.—Changes in the peripheral resistance influence the height of the blood pressure enormously, and it is the state of contraction of the arterioles which mainly controls the extent of the resistance. Constriction or dilatation of the arterioles, dependent upon impulses through the vaso-motor nerves, will increase or decrease the pressure. The vessels of the arteriole and capillary fields may contract or dilate in sections from local and other causes. As Brunton has pointed out, there are three channels through which the blood finds its way from the arteries into the veins. There are the vessels of the skin, the vessels of the intestine, and the vessels of the muscles. Little attention has been paid, hitherto, to the vessels of the muscles in this connection, but according to Brunton, the outflow through these is equivalent to that of the other two channels together. The important point with regard to the blood pressure is, that although the vessels of the skin and intestine are contracted, yet the peripheral resistance may not be much increased, and a higher blood pressure may not result; the blood still escapes freely through the vessels of the muscles. Vaso-constriction causes the left ventricle to contract more powerfully, and tends to slow the pulse; a slow pulse, therefore, generally indicates a higher blood pressure than a fast pulse. Dilatation of the vessels causes a quickening of the heart, and this, according to the researches of MacWilliam, is almost always due to the suspension of vagus activity; it is very doubtful whether the same result is ever dependent upon stimulation of the sympathetic.

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[1] White spirit-varnish (shellac dissolved in spirit) may be recommended to fix the smoked papers.

[2] This time-marker is fitted to the sphygmograph by Mr. W. M'Gregor, watchmaker, Castle Street, Edinburgh.

Relation to Arterial Walls.—From what has been already said it will be seen that the relation of the blood pressure to the state of the arterial walls is a very complex one. The radial pressure may be considerably increased both when the vessel walls are felt to be tightly contracted, and also when the artery is large and relaxed. In the one case there is a contraction of the muscular coats of the arterioles and larger arteries from direct or indirect irritation of the vaso-motor centre. This condition is typically present in some cases of tubercular meningitis and cerebral tumour, and it may also be induced reflexly by severe abdominal pain, tympanites following a laparotomy, and profound shock. This kind of arterial spasm may sometimes be unilateral, in neuralgias, lead colic, etc. In the other case the radial blood pressure is raised by increased peripheral resistance mainly confined to the capillaries. The artery is then large, and the pulse may be full and bounding. Obstruction of the capillaries, due to various toxins in the blood, is the commonest and most persistent cause of high blood pressure. Sometimes when the pulse feels small and weak, owing to involvement of the radial artery in the area of increased peripheral resistance, the blood pressure in this vessel may not be increased, and yet, as Oliver points out, it may be greatly raised in the central arteries.

When the arterial walls are thickened and sclerosed, the blood pressure is not always raised. The calibre of the vessel may be increased or diminished, but the blood pressure may, in either case, be high or low. In the young the elastic wall of the artery plays an important part in maintaining a good blood pressure, and as age advances the resiliency of the vessel is largely impaired. In very old people the contracted "field of response" of the heart is a factor which must be taken fully into account; for this reason a low blood pressure may be present when the radial artery is hard and cord-like.

In forming an estimate of the blood pressure the important point to note is the *compressibility* of the vessel—the force necessary to obliterate the pulse wave. In advanced life the thickened condition of the radial walls may lead one to call the pulse one of "high tension," but, in some cases, from the ease with which the finger can obliterate the pulse, we judge the actual blood pressure to be low.

Relation to Pulse-Rate.—Marey has shown that the blood pressure controls the rate of the heart's action—the pulse-rate varies inversely as the arterial pressure. In normal conditions high pressure in the vessels slows the pulse, and a low pressure quickens it, but sometimes the important factor in maintaining a good pressure in the arteries is the *increased rate* of the pulse. Thus in the infant the heart's action is exceedingly rapid, and only a small quantity of blood is thrown into the aorta by each ventricular contraction. The pulse at this age is of small volume, but it is one of relatively high pressure. At this age an adequate pressure is maintained by a series of rapid and weak systoles; in later life the same result is attained by slower and more powerful ventricular contractions.

Relation to Volume of Blood in the Circulation.—The total volume of blood in the circulation is another important factor in the blood pressure, and every change by abstraction or addition alters the pressure. But the alterations produced on the circulation by venesection or transfusion are of a very temporary kind. Hæmorrhage up to 2 per cent or 3 per cent of an animal's weight scarcely affects the blood pressure at all, but up to 4 per cent or 6 per cent of the body weight the pressure may temporarily fall to nearly zero. After severe hæmorrhages an average pressure is soon restored by increased absorption of fluids from the tissues into the circulation, and though transfusion may raise the blood pressure for a time, and thus tide a patient over a period of great danger, the increased pressure is not maintained. In certain toxæmic conditions, indeed, where the blood pressure is abnormally high owing to extensive arterial spasm, as occurs in some cases of puerperal eclampsia, the writer has shown that one of the early effects of adding to the fluid in the circulation, by giving large saline infusions, is to lower the blood pressure remarkably (Figs. 4 and 5). This effect is probably brought about by the dilution of a toxin, which, by inducing vaso-constriction, greatly increases the peripheral resistance. Venesection, even when freely practised, will not permanently reduce the general arterial pressure, but as a temporary expedient, and particularly as a means of relieving the heart and lungs, it is of very great value.

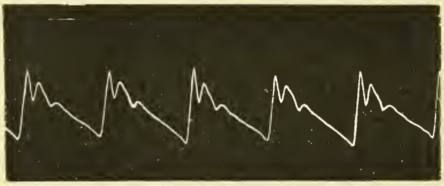

FIG. 4.—Radial sphygmogram from a young primipara suffering from puerperal eclampsia. Slow pulse of high pressure. Vessel wall markedly contracted.

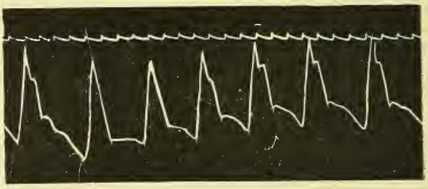

FIG. 5.—Tracing from the same patient shortly after an infra-mammary infusion of one pint of saline solution. Quicker pulse of diminished pressure with relaxation of arterial walls. (enlarged calibre).

Relation to Composition of the Blood.—Wrong composition of the blood, as well as alterations in the specific gravity of the plasma, by unsettling the regular onflow of the corpuscles through the capillaries, will increase the peripheral resistance and raise the blood pressure, *e.g.*, Bright's disease, anæmia, etc.

Relation to Respiration.—Respiration acts on the blood pressure in two ways. Generally speaking, inspiration lowers the pressure, while expiration increases it, but with a high arterial pressure these effects may be very slight.

MEASUREMENT OF THE ARTERIAL PRESSURE IN MAN

The Mean Arterial Pressure.—The educated finger can recognise when the arterial pressure is unduly high or abnormally low, but in health there is a certain pressure maintained in arteries as a resultant of the factors already mentioned.

Hamilton expresses it tersely thus: he says—"Were the heart to cease beating, the aortic valves to be closed, and the capillary outlets to be occluded simultaneously, the pressure of the blood within the arteries would represent this mean pressure." The intra-arterial blood pressure varies between two extremes—the maximum, which occurs during the ventricular systole, and the minimum, which is present between the pulsations, during the ventricular diastole. The relations which these two pressures bear to each other may vary greatly. In cases of high blood pressure, *e.g.* Bright's disease, the systolic and diastolic pressures approximate, while some cases of low blood pressure, *e.g.* aortic regurgitation, show greatly increased pressure during the ventricular systole, and a great diminution during the diastole. The terms "minimum pressure" and "mean pressure" are sometimes used synonymously, but others place the mean pressure at some point between the diastolic and systolic pressures.

Methods of Estimating the Blood Pressure.—There are at the present day many instruments — sphygmometers — which are used to measure the blood pressure in the human subject. There are two methods in which this may be attempted, and two distinct principles are involved. Some of the instruments profess to gauge the pressure necessary to obliterate the pulse; this is the idea underlying the method of von Basch, and it is intended to register the maximum or systolic blood pressure. Other forms of sphygmometer are based upon a principle suggested by Marey, which consists in increasing the pressure on the outside of an artery until the pulse-wave attains its greatest amplitude. This method was originally adopted by Mosso, and all the instruments of recent introduction make use of this principle. It would seem probable that this method, when properly carried out, must give the minimum or diastolic pressure; for experimental proof that this is so the reader is referred to an excellent article by Drs. Howell and Brush (*Boston Med. and Surg. Journ.* vol. cxlv. No. 6). This, however, is not the invariable view taken, for in the Hill-Barnard instrument, which adopts this principle, the maximal pulsation, according to Hill, indicates the mean arterial pressure and not the diastolic.

The method of determining the arterial pressure in man by obliterating the pulse (von Basch, Potain, and others) should give the systolic or maximum pressure in the artery examined. But all the instruments on this principle really give a supramaximal reading, and are seldom employed.

Of instruments constructed on the other principle—that of increasing the pressure on the outside of the artery till it equals the pressure within—there are many forms. One of the simplest has been introduced by Hill and Barnard, and the writer here quotes Hill's description of the method and results from Halliburton's *Physiology* (4th ed.):—

"The instrument consists of a vertical glass tube about 5 inches in length, which expands above into a small bulb, and is closed at the top by a glass tap.

"A small india-rubber bag is fixed to the tube below; this is surrounded by a metal cup, attached in such a way that only the base of the bag is exposed. The bag is filled with coloured fluid. On pressing the instrument down over the radial or other artery the fluid rises in the tube and compresses the air in the bulb; the air acts as an elastic spring. The more one presses the more the fluid rises; at a certain height the meniscus of the fluid exhibits more pulsation than it does at any other height (*maximal pulsation*). The tube is empirically graduated in divisions that correspond to millimetres of mercury pressure. The point of maximal pulsation gives the arterial pressure. Before each observation the tap is opened, and by gentle pressure on the bag the fluid is set at the zero mark on the scale. Thus errors due to changes in barometric pressure or temperature are avoided.

"We now come to the explanation why the maximal pulsation gives us a reading of arterial pressure. If the mean pressure inside and outside an artery be made equal, then the wall of the vessel is able to vibrate at each pulse with the greatest freedom. The mean pressure is less than the systolic, but greater than the diastolic pressure; thus during the heart's systole the artery is opened out to its fullest extent, while during the heart's diastole its lumen is obliterated; hence the vessel wall swings with the greatest amplitude. If the pressure exerted by the sphygmometer is less than the mean arterial pressure, the artery will not be compressed to its utmost during diastole; if, on the other hand, the pressure exerted is greater than the mean, the artery will not fully expand during systole. In either case the pulsation will not be so great as when the pressure exerted on the outside of the artery equals the mean pressure within.

"By recording the arterial pressure in the dog with a mercury manometer, and at the same time taking readings with the sphygmometer, the instrument has been proved to give accurate results."

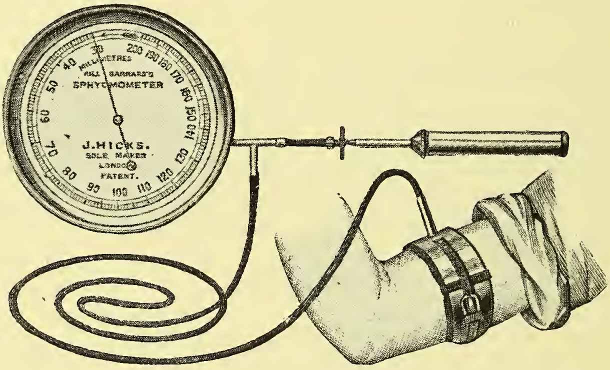

FIG. 7.—Hill and Barnard's Sphygmometer.

Hill and Barnard have invented a larger instrument on the same principle, which takes the pressure in the large arteries of the arm just above the elbow. A thin india-rubber bag, fixed inside a leather armlet, is strapped round the arm. The india-rubber bag is connected by a T-tube with an air-pump and a spring manometer (Fig. 7). The pressure in the bag is then raised until the needle of the manometer gives its maximal pulsation, when the mean pressure is accurately registered. We think there are many obvious fallacies in the results obtained with this instrument, and among these we may mention the elastic walls of the bag and tubing, the air conduction to the recording apparatus, the muscular development of the arm.

In recording the blood pressure with either of these instruments it is sometimes difficult to determine the point at which maximal pulsation occurs. Thus the movement may be large, between 140 and 150 mm. on the scale; may become distinctly less at 130 mm., and may then appear as great as before at 120 mm. Which reading in these cases indicates the mean arterial pressure? But the maximal pulsation can often be readily noted, and then a definite reading is obtained. While the writer does not think that this reading can always be taken as representing the *mean* arterial pressure, still in a given case he believes it indicates the general state of the pressure. For comparative purposes this would seem to be sufficient, and the variations in the readings from day to day will furnish valuable information; the method used gives reliable results when a series of observations are made on the same patient.

According to Hill's observations the normal pressure in the radial artery in healthy young adults is 110 to 120 mm. of Hg, and it appears to be as constant as the body temperature.

Dr. George Oliver has devoted much time to the study of the normal variations of the blood pressure under various physiological conditions, and also to certain abnormal variations produced by massage, cold baths, etc. He has contributed largely to our knowledge on these subjects, but in this place we shall only refer briefly to new instrumental methods of observation introduced by him.

To overcome the manifest difficulties encountered in determining the blood pressure in man, Dr. Oliver has shown very great ingenuity and originality. He has carefully considered the matter from every point of view, and has arrived at the following conclusions:—

(1) That the blood pressure in man can be correctly estimated through a fluid medium, but not through a solid one.

(2) That variations in the resistance of the tissues do not vitiate the correct reading of the mean arterial blood pressure.

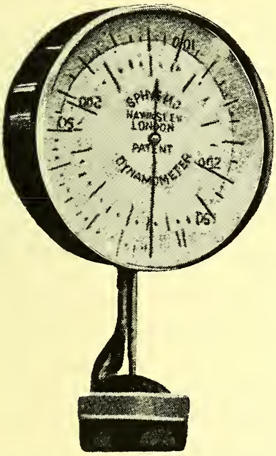

Fig. 8.—Oliver's Hæmodynamometer.

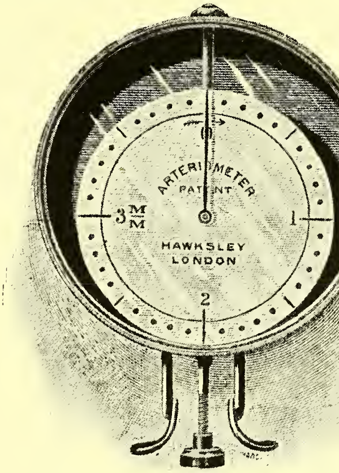

Fig. 9.—The Arteriometer (Oliver's).

(3) That variations in the calibre of the arteries do not disturb the reading of the mean arterial pressure.

(4) The adoption of the fluid principle obviates the errors due to the malposition of the solid pad and to abnormal conformation.

The Hæmodynamometer, or Blood-pressure Gauge.—Dr. Oliver's hæmodynamometer, or blood-pressure gauge (Fig. 8), consists of two main parts—(1) the pad; and (2) the recorder. The pad is made of thin rubber, and is filled with water containing a little glycerine. It is placed over the radial artery and transmits the pulsations of the vessel to the recording apparatus.

The principle followed is to equilibrate the fluid pressure within the pad to that within the artery, so that when that point is reached, the two pressures being exactly balanced, as it were, and the pad then being but a diverticulum of the artery, the maximum motion of the pulse-wave is developed. In principle it is identical with the sphygmometer of Hill and Barnard, but it is a more convenient form for clinical use.

We have tested both these instruments together on a series of patients in order to ascertain how the readings would compare in estimating a blood pressure. With Dr. Oliver's instrument a much higher mean arterial pressure was invariably indicated. We are, therefore, of opinion that there is still no ready and accurate means of estimating the arterial blood pressure in man. Dr. Oliver's observations with his hæmodynamometer are reliable, so far as the instrument determines, and in his hands supply valuable information; but what we wish to emphasise is that there is, as yet, no means available to the general practitioner of estimating the blood pressure clinically in a manner at all comparable to taking the temperature.

The Arteriometer.—The other instrument devised by Dr. Oliver—the arteriometer—is used to measure the calibre of any superficial artery (Fig. 9). Two conditions must be observed in order to make the reading as reliable as possible—(1) the wrist must always be extended at a uniform angle; and (2) the same part of the artery must be observed on all occasions.

We have a high opinion of the value and scope of usefulness of this little instrument. We have used it frequently, and have found it to indicate a diminution of the radial calibre when the finger judged the artery to be contracted. Dr. Oliver has made very numerous observations on the calibration of the arteries in health and disease, and some of his results are extremely suggestive.

THE INTERPRETATION OF THE SPHYGMOGRAM

The Normal Sphygmographic Tracing.—Fig. 10 will serve to show the various parts of a typical sphygmogram from the radial artery. Certain points may be noted: the up-stroke (*a*), the apex of the tracing (*b*), the beginning of the down-stroke (*c*), the tidal or predicrotic wave (*d*), the dicrotic or aortic notch (*e*), the dicrotic wave (*f*), and, lastly, the remainder of the down-stroke. At the point *g* there is sometimes a second elevation similar to the dicrotic wave, but smaller—the post-dicrotic wave (Fig. 11). At *h* the down-stroke ends; and, according to some, that portion between *g* and *h* indicates the period of rest in anticipation of the ventricular contraction. The lowest point of the tracing has been called the base line by Landois, and the respiratory line by Mahomed. Its level may vary with the movements of respiration, particularly when there is great dyspnœa.

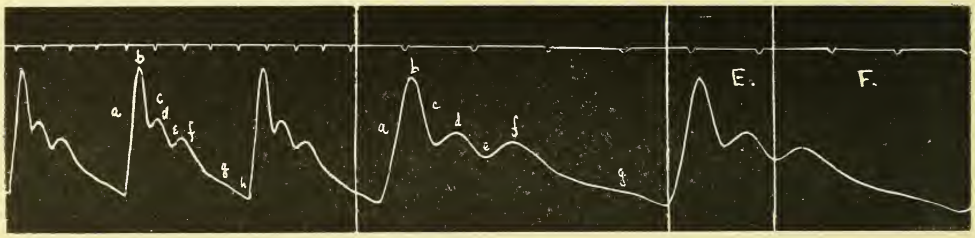

FIG. 10.—Normal sphygmographic tracing. *a*, The up-stroke; *b*, the apex of the tracing; *c*, the down-stroke, which may be of varying length; *d*, the so-called tidal or predicrotic wave; *e*, the dicrotic or aortic notch; *f*, the dicrotic wave; *g*, the post-dicrotic wave; *h*, termination of down-stroke. E, the systolic portion of the pulse curve—the "*systolic wave.*" F, the diastolic portion of the pulse curve.

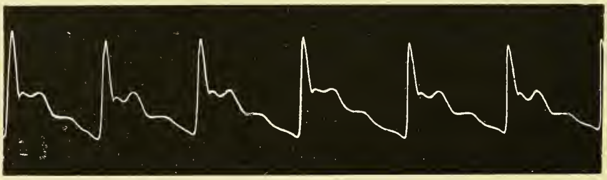

FIG. 11.—Radial sphygmogram showing the post-dicrotic wave.

While all observers are agreed upon the main features of the sphygmographic tracing as above indicated, much difference of opinion still exists as to the mode of production of the various events, and as to their individual variations. We may shortly review some of the interpretations put upon the pulse-curve.

The up-stroke of the needle means a rise of arterial pressure, and it is commonly called the percussion stroke, because it is usually produced by the shock received by the blood column on the sudden bursting open of the aortic valves, which is transmitted almost instantaneously throughout the whole arterial system. Then with the commencement of the down-stroke a fall in blood pressure is indicated, and a rounded or pointed wave (*a, b, c*) is formed. This portion of the tracing is called the *percussion wave* by some, and includes the so-called percussion stroke. The next feature is the *tidal* or *predicrotic wave* (*d*). Some writers explain it in this way: when the pressure in the artery begins to fall, the decline of the needle is delayed by a brief period of maintained expansion, which may amount to an actual wave of renewed expansion. This elevation is much more marked in tracings made from the carotid and brachial arteries, *i.e.* nearer the heart. The instrument exaggerates this feature of the sphygmogram.

The next event, however, the *dicrotic wave* (*f*), corresponds to a true secondary wave of increased blood pressure in the arterial system. The *dicrotic notch* (*e*) marks very precisely the time of closure of the aortic valves.

After these general statements it is necessary to discuss some of the features of the pulse-curve more particularly. It may be said at once that much confusion has arisen from the use of the terms "percussion wave" and "tidal wave" in describing the sphygmogram. It is admitted by all that these two waves occur during the systolic contraction of the ventricle, and that the other waves occur during its diastole. Yet the percussion wave is usually regarded as a distinct event in the pulse-curve, which should be entirely separated from the tidal wave except under certain conditions where the two waves are blended to form a single summit to the tracing. Mahomed regarded the systolic portion of the pulse-curve as composed of two factors, *i.e.* the percussion and the tidal waves. The percussion wave he described as the sudden primary expansion of the artery due to the shock of systole on the aortic contents; the tidal wave he supposed to be due to the more gradual distension of the artery. Burdon Sanderson says: "As a rule, the sensibility of the finger is most affected at the moment the artery attains its acme of tension, *e.g.* at the height of the tidal wave, but in low tension pulses the same cause which jerks up the lever of the sphygmograph (percussion stroke) communicates the first sensation to the finger." It will be instructive to quote the following passage, from the writings of Mahomed, bearing on the significance of the tidal wave. He said: "The simplest pulsatile movement that can be conceived in an elastic tube is the mere passage of a wave of fluid through it, causing more or less sudden expansion and a gradual collapse of the tube, as it passes through it; such a wave is the foundation of the pulse, and has been called the 'tidal' wave. If the impulse imparted to the fluid is more sudden, an element of percussion or shock will be introduced, giving an abrupt and vertical up-stroke, from the jerking up of the lever by the sudden expansion of the artery. Owing to its acquired velocity, this movement of the lever is rather greater than the corresponding movement in the arterial wall which produced it, and on reaching its highest point it falls suddenly by its own weight, till it is again caught and perhaps slightly raised by the tidal wave, which is now only reaching its maximum of distension. . . . The tidal wave is the true pulse-wave, and indicates the passage of a volume of blood through the arteries, pumped into them by each contraction of the heart. It resembles the passage of the tidal wave or 'bore' up a river; hence its name. It is transmitted more slowly than the percussion wave, or rather attains its maximum intensity more gradually; hence their separation in the tracing. Though they usually commence to distend the artery together, the percussion wave necessarily attains its maximum intensity instantaneously, it being only a shock, while the tidal wave does so more gradually. Sometimes a considerable interval elapses between them. Frequently they are inseparable, the percussion wave not existing or else being merged into the tidal."

Although Mahomed here makes use of the terms "percussion" and "tidal" waves, still he appreciates the important fact that the former is of instrumental origin when it appears as a separate apex to the pulse-curve. From this description we are led to a true conception of the systolic portion of the sphygmogram.

The Systolic Wave.—From a study of simultaneous tracings of the pulse, aortic pressure, apex beat, and intra-ventricular pressure, as worked out experimentally by Hurthle, von Frey, and others, it is clear that the up-stroke of the sphygmogram coincides exactly with the rise of the aortic pressure—the so-called percussion wave does not occur earlier than this, and therefore it must not be regarded as a separate event in the tracing (Fig. 12). Dr. James Mackenzie has greatly simplified matters by applying the term *systolic wave* to the first part of the sphygmogram, from the commencement of the rise to the dicrotic notch. This, in the writer's opinion, is the most correct and rational method of interpretation yet adopted, and it indicates the true relationship of the ventricular and arterial pressures.

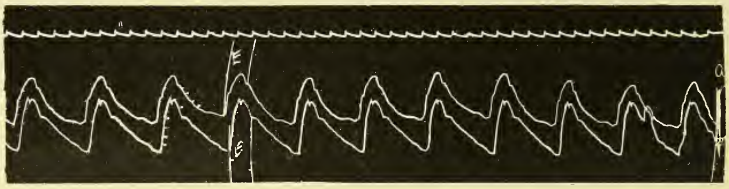

Fig. 12.—Simultaneous tracings from the aorta (fusiform dilatation) and radial pulse. The spaces E represent the duration of the ventricular outflow; the up-stroke of the sphygmogram corresponds exactly with the rise of the aortic pressure. (Time register in fifths of a second—writer's time-marker.)

The principal fact to lay hold of is this, that there is only a *single* wave movement produced in the arterial system at the time the ventricular contents are forced through the aortic valves, and this, as Mackenzie suggests, may be called the systolic wave.

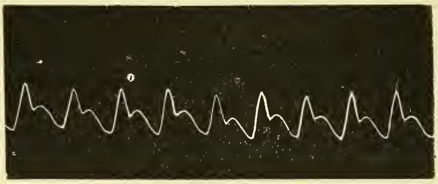

Fig. 13.—The systolic and dicrotic waves—the true intra-arterial waves.

In the tracing of a low pressure pulse (Fig. 13), the heart movement which gives rise to this wave is apparent as a single elevation, and then the second and slighter increase in arterial pressure which follows is depicted as the dicrotic wave. Therefore, when the radial artery is compressed by the pad of the sphygmograph, these two waves—true intra-arterial waves of pressure—produce two expansions of the vessel, and the simplest type of sphygmogram is represented.

The Dicrotic Wave.—With regard to the nature of the dicrotic wave we may give the following explanation:—After the completion of its systolic contraction the ventricle begins to relax, and in doing so any support afforded to the aortic cusps by its contracted walls is withdrawn. A negative wave is thus set up which travels towards the heart. This wave is arrested by meeting the closed aortic valve, and is reflected as a positive wave towards the periphery. Hence it is accompanied by a renewed rise in the blood pressure, and is indeed sometimes appreciated by the finger as a second though feebler pulse-wave.

That the two waves—systolic and dicrotic—are the only essential ones in a pulse-tracing is easily demonstrated by allowing the blood to spurt from a cut artery on to the surface of a revolving drum, when the so-called hæm-autograph is obtained.

Modifications of the Systolic Wave.—It so happens that what is generally described as the normal sphygmographic tracing shows more than these two waves, for between the summit of the first wave and the dicrotic notch there is a second upheaval (Fig. 10). This upheaval may sometimes rise to a higher level than the first summit, or it may be poorly represented. The systolic wave may therefore appear in the sphygmogram as a single curve, or it may be broken up into two or more distinct elevations owing to the participation of other factors. The sphygmograph plays an important part in the breaking up of the systolic wave, but the arrangement of the two summits—*i.e.* the time of occurrence of the second wave—is determined largely by the degree of obstruction to the outflow of blood from the ventricle into the aorta, and also by the state of the resistance in the peripheral arteries. Thus interference with the propagation of the systolic wave from marked narrowing of the aortic orifice will produce a fairly constant and characteristic modification of the summit of the sphygmogram —the wave is broken up early, and the second elevation, which may be pointed or rounded, forms the highest part of the tracing (Fig. 14).

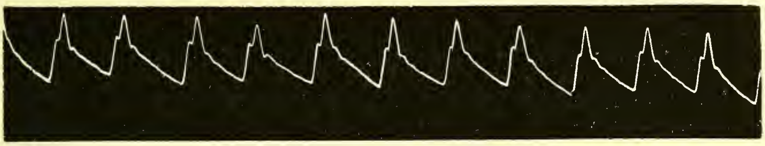

Fig. 14.—The modification of the systolic wave in aortic stenosis—the second summit forms the highest part of the tracing.

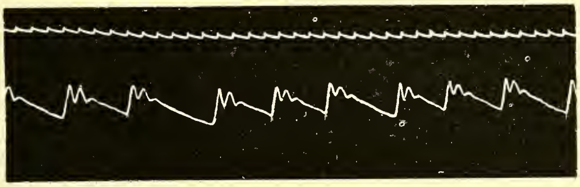

Fig. 15.—Modification of the systolic wave produced by moderate peripheral resistance. There are two summits of about equal size with a notch between them. (Tubercular meningitis—child, æt. 5 years.) The type of pulse irregularity is also shown.

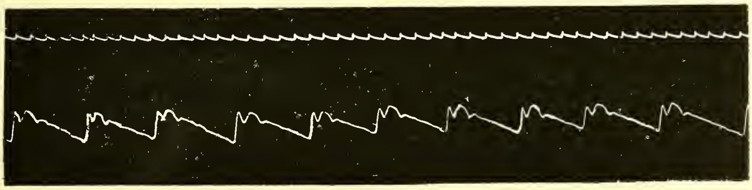

Fig. 16.—Modification of the systolic wave produced by pronounced increase in peripheral resistance. (Tubercular meningitis—child æt. 3¼ years.)

Again, with the normal propagation of the systolic wave a contracted state of the peripheral arteries may also lead to a fairly typical division of the summit. Both waves may be of about equal size, with a notch of varying depth between them (Fig. 15). With greater peripheral resistance the tracing is frequently of the type shown in Fig. 16, and should the resistance become still further increased the pulse may become anacrotic (see p. 205). Under certain conditions, *e.g.* pyrexia, where the peripheral vessels are dilated and the ventricles excited, a somewhat similar summit may be formed, and is entirely due to instrumental defects. In some cases of aortic regurgitation without stenosis, this kind of summit is frequently seen (Fig. 17).

The manner in which the systolic wave is broken up is, in many cases, suggestive, but the writer agrees with Mackenzie that it is better to discard all terms of signification in naming the various summits. There is the single heart wave—the systolic wave—and the dicrotic wave, which is dependent upon the closure of the aortic valves. Modifications in the outline of this simple form of sphygmogram may result from the participation of the other factors mentioned.

Views of Roy and Adami.—The views of Roy and Adami as to the origin of the leading features of the systolic portion of the pulse-tracing may be briefly referred to; but, for the reasons in favour of such changes in nomenclature as they suggest, their paper must be consulted (*Practitioner*, 1890). Roy and Adami lay great stress upon the mode of cardiac contraction, and, generally speaking, they recognise, in addition to inertia waves, *three* heart waves. The up-stroke corresponds to a primary heart wave, and is due to the ventricular contraction; for the percussion wave of Mahomed they substitute the term *papillary wave*, as they believe this to be due to the late and transient contraction of the papillary muscles; the tidal or predicrotic elevation is called the *outflow-remainder* wave, on the ground that it results from a continued contraction of the heart wall, which persists longer than that of the papillary muscles.

Roy and Adami, in studying the pulse-curve, made use of an instrument called the sphygmometer (see *Practitioner*, vol. xlv. p. 29, 1890). With this instrument the authors claim that the pressure upon the artery can be regulated exactly; that the tracings are sufficiently large to enable one to distinguish minute variations in the characters of the pulse-wave; that the curves are free from inertia vibrations; and, lastly, that the blood pressure within the artery can be measured.

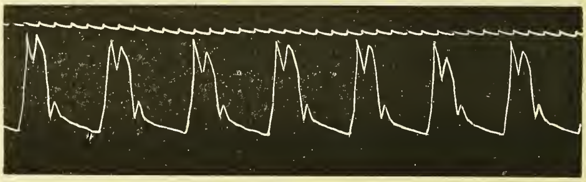

Fig. 17.—Pulse in aortic regurgitation without stenosis. The double summit of the systolic wave is of instrumental origin.

Views of von Frey and von Kries.—Von Kries and von Frey, in their interpretation of the pulse-curve, adopt the view that there is only a *single* heart wave, and that there are rebounds of this wave within the arterial system. Waves set up within an artery may rebound from the points of division of the vessel, but the chief site of rebound is the periphery of the vascular system—the capillary area. These waves modify each other by interference.

Von Frey concludes that the thorough discussion of any pulse-tracing is, strictly speaking, impossible in the absence of a knowledge of the number, origin, and direction of the waves which share in its production.

From recent observations by Leonard Hill and others it would seem not impossible that the degree of distension of the venæ comites in the radial sulcus may affect the pulse-tracing, as it may also mislead one in forming an estimate of the pulse by means of the finger. According to these observers the radial sphygmogram must be interpreted as a pressure curve, for the movements of the lever of the sphygmograph are produced by the changes in pressure in the vessels which lie in the radial sulcus. We think undue importance has been ascribed to venous influence, but we shall refer to the matter again under the section of pulse and respiration.

Digital Sphygmographs.—It must be borne in mind, however, that when the pulse is felt in the usual way, or when the pad of the sphygmograph is applied over its site, a much more complex set of movements is obtained than is generally recognised. Thus the tracing is more than a diagram of the changes of blood pressure within the artery. It is perhaps more correctly to be regarded as a representation of a communicated pulsation from the vessel to the tissues and liquids surrounding it. Thus the writer has taken tracings from the pulp of the middle finger by means of Dudgeon's sphygmograph, which exhibit all the features of an ordinary radial sphygmogram (see Fig. 18). Digital sphygmographs which record the pulsations of the vessels of the nail bed have been in use during the last few years, and Waller has recently described a very useful instrument of this kind under the name of the "onychograph."

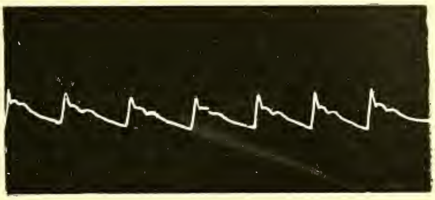
Fig. 18.—Tracing from the pulp of the middle finger (Dudgeon's sphygmograph) (identical with radial sphygmogram).

The Inverted Sphygmogram.—It must not be forgotten also that there is some displacement of the whole artery in its bed at each systole of the ventricle. Allen Thomson believed this locomotion of the artery to be produced by the distension and elongation of the larger vessels near the heart, and in many persons the radial artery may be seen to move under the skin. These displacements are most easily seen in atheromatous arteries at their curvatures, and where they adhere to surrounding tissues. There is sometimes a considerable movement of the radial artery at the time of the ventricular systole, and there is a consequent "sucking-in" of the tissues adjacent to it. This is well shown in the tracing, Fig. 19, where the pad of the sphygmograph was placed alongside a large radial artery. The lower tracing in the figure shows that the needle of the instrument instead of being shot upwards at the time of systole, as in the upper tracing, is drawn backwards, thus forming an inverted diagram of the normal curve. Mackenzie figured similar tracings to show the effects of the sudden movement of the carotid artery in the neck.

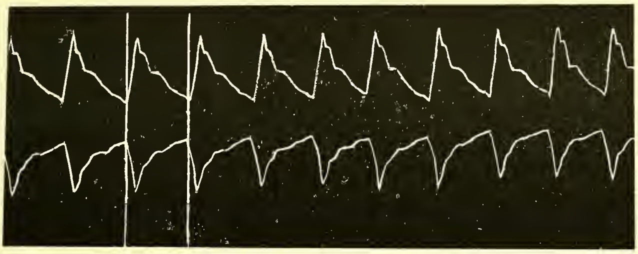
Fig. 19.—The upper tracing was taken from the radial artery in the usual manner; the lower one was taken with the pad of the sphygmograph lying alongside the artery. The lower tracing is an inverted sphygmogram.

General Information afforded by a Sphygmogram.—From a good sphygmogram we obtain information on many points in connection with the heart and circulation: (1) we ascertain the rate and rhythm of the heart; (2) we become acquainted with certain events occurring during the cardiac systole; (3) we get some indication of the state of the blood pressure; (4) we can form some idea of the state of the arterial walls.

We can only judge the height of the blood pressure in a general way from the form of the pulse-curve. When the systolic wave appears as a single summit, we may usually assume that the blood pressure is relatively low (Fig. 20). When a large systolic wave is divided by a notch, and the second summit is large and well sustained, the pressure in the vessels is generally high, but is not always so in people over sixty years of age (Fig. 21).

Some Features of the Sphygmogram due to Instrumental Defect.—There are certain well-marked features in many tracings made with Dudgeon's sphygmograph which are undoubtedly due to a defect in the instrument. It is well to recognise this, and defects thus caused are not altogether undesirable so long as their undue exaggeration is avoided. With care it is possible to do so, but in some low pressure pulses the interpretation must always be somewhat uncertain. Thus when the needle is jerked up very forcibly the apex of the systolic wave is very pointed, or may even be looped (Fig. 22). The needle, from its momentum, has formed an apex to the curve which is out of all proportion. When this happens, the fall of the needle is also apt to be too extensive, and may come down to the level of the base line or below it. The lowering of the blood pressure during the diastole of the ventricle will thus appear to be very sudden and extreme, which it really is not (Fig. 23).

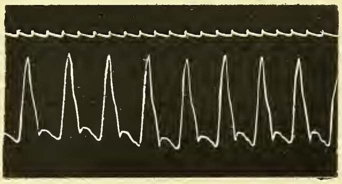

Fig. 20.—Systolic wave as a single summit—blood pressure relatively low.

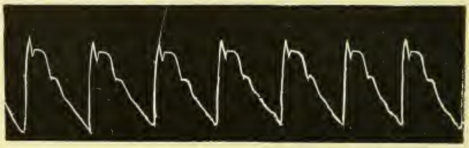

Fig. 21.—Large divided systolic wave, with second summit well sustained—blood pressure high.

The Anacrotic Pulse and the Bisferiens Pulse.—These two forms of sphygmogram may be conveniently considered together, as a description of the former will include most of the features of the latter. The writer sees no reason to regard them as separate types.

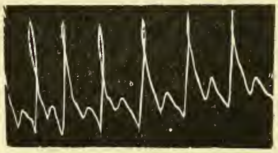

Fig. 22.—Looping of systolic wave (instrumental defect).

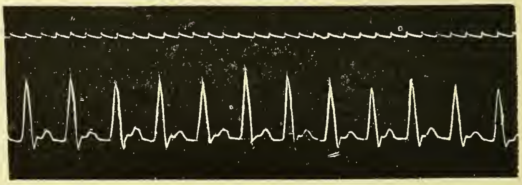

Fig. 23.—Too great falling of the first summit of the systolic wave (instrumental defect).

The *anacrotic* pulse may sometimes be a true representation of the course of events in the artery, and it is generally supposed to be characteristic of marked obstruction to the outflow of blood from the ventricle into the aorta, *e.g.* aortic stenosis. Graham Steell, in describing the pulse in aortic stenosis, recognises two distinct varieties: (1) the anacrotic pulse; and (2) the bisferiens pulse. According to this authority, the former is the more characteristic pulse in narrowing of the aortic orifice, owing to its sluggish development and infrequency; the latter has a more perpendicular up-stroke, a pointed percussion wave, and the cleft between this wave and the tidal wave is very deep. The tidal wave itself is pointed, and the aortic notch is usually situated low down in the line of descent. The dicrotic wave is usually, but not always, ill-developed.

Steell thus describes the features of the anacrotic pulse:—(1) The up-stroke slopes instead of being perpendicular; (2) the percussion wave is practically abolished; (3) the tidal wave forms the summit of the curve; and (4) the dicrotic wave is usually ill-developed. In addition he notes the characteristic slowness of the pulse, which is an important point. This description coincides with Mahomed's idea of the simplest pulsatile movement in an elastic tube, where the pulse-wave, being slowly delivered, is not modified by the percussion element. In the anacrotic pulse the systolic wave may in some instances appear as a single rounded summit (Fig. 24), or under other conditions there may be a distinct break in the line of the up-stroke (Figs. 25 and 26). Among other factors the delicacy of the sphygmograph is responsible for the degree of development of this notch. The ventricle, for one reason or another, has some difficulty in delivering its contents into the aorta, and hence there is not the usual sudden sharp impact imparted to the column of blood in the arterial system. The systolic wave then, if graphically recorded, will appear as a single sluggish elevation or as a divided summit, according to the delicacy of the instrument employed. The notch may occur at any part of the upstroke, and sometimes it occurs at the top of the curve, thus giving rise to a double summit (Fig. 27). The second summit tends to rise more and more above the level of the first-formed apex in the so-called anacrotic pulse, and is usually well

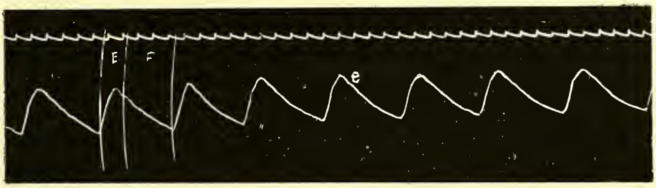

Fig. 24.—Anacrotic pulse, where the systolic wave appears as a rounded summit. E corresponds to the systole of the ventricle; F corresponds to the diastole of the ventricle. High position of dicrotic notch (*e*).

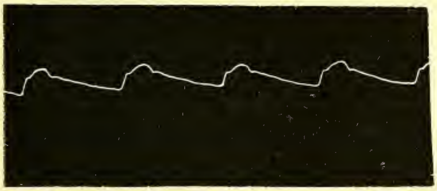

Fig. 25.—Typical anacrotic pulse from case of aortic stenosis.

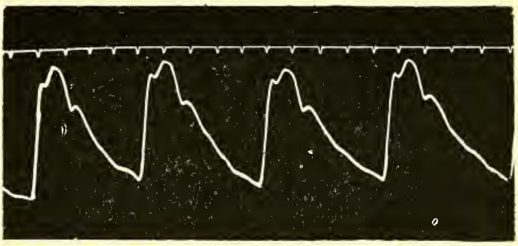

Fig. 26.—Pulse in aortic stenosis. (Von Jacquet's sphygmograph) (anacrotic type).

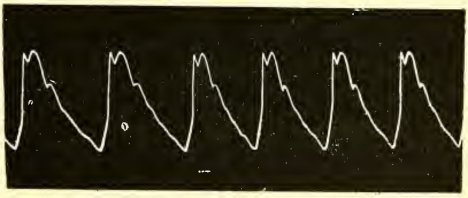

Fig. 27.—Anacrotic pulse. Shows the notch dividing the two summits of the systolic wave at the top of the curve.

sustained, but this last feature depends on other factors. If there is a relatively powerful left ventricle, and perhaps some pyrexia, the two waves forming the summit may be equally large and pointed, and the cleft between them may be very deep. The up-stroke is then more sudden and of greater amplitude. *Exaggeration* of these waves is of instrumental production, and it is in this way that the bisferiens pulse is formed (Fig. 28). The writer does not think this type of sphygmogram occurs in cases of pure aortic stenosis unless there is an elevation of the temperature, or at any rate some diminution in the peripheral resistance

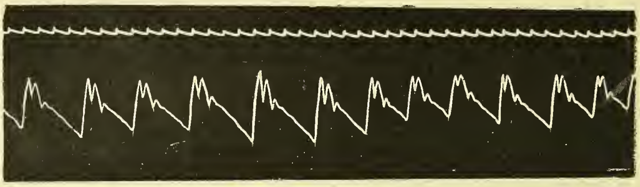

Fig. 28.—Pulse from a child suffering from tubercular meningitis which has assumed the *bisferiens* type under the influence of slight pyrexia. This pulse, when the vessels were more contracted, gave an *anacrotic* curve.

A form of curve very similar to the pulsus bisferiens is commonly obtained in cases of aortic incompetence without stenosis, but the second summit is then rarely so high as the primary one (see Fig. 17). The double summit under these circumstances is entirely dependent upon the sudden and forcible manner in which the systolic wave is developed in the relatively empty arterial system.

The writer would define the *bisferiens* pulse as one in which the systolic wave is broken up into two more or less pointed summits of about equal size, the second summit *always* rising to a higher level than the first. This last feature is the important one, and it belongs also to the anacrotic pulse. Under certain circumstances the anacrotic pulse may become modified into the bisferiens pulse, and, generally speaking, the former co-exists with a relatively higher blood pressure than the latter.

To return to the anacrotic pulse, we may state that obstruction to the outflow of blood at the junction of the ventricle and aorta is not the only, or even the chief, condition which produces this modification of the systolic wave, though some of the most characteristic tracings may be obtained in aortic stenosis. Anything which tends to abolish the percussion element in the wave and which leads to the more gradual transmission of the impulse within the arterial tube, will produce a rounded or anacrotic curve. Tracings made with the plethysmograph of the pulsation of the arm or leg as a whole are generally anacrotic. The normal form of intracranial pulse, taken from the fontanelle or from a gap in the skull, is anacrotic.

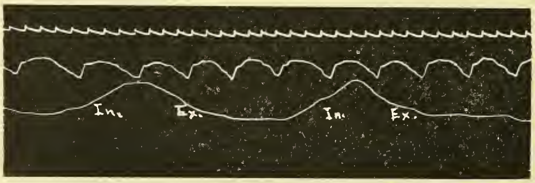

Fig. 29.—Tracing from a plexiform angioma of the scalp, showing the anacrotic character of the pulse curve. The lower tracing is a respiratory one.

The writer recently made tracings from a plexiform angioma, which pulsated as a mass under the scalp of a child aged seven years. The type of curve obtained was also anacrotic (see Fig. 29).

In very young infants the sphygmogram of the radial artery is frequently anacrotic, and the same kind of pulse-curve is obtained in some cases of aneurism of the aorta in adults, for reasons which will be stated hereafter. But in the opinion of the writer the most powerful single factor in the production of the anacrotic pulse is *contraction of the peripheral vessels.* In children he is convinced that this is so, and in some cases of tubercular meningitis, where even the larger arteries (radials) are tightly contracted, this form of sphygmogram is very characteristic. Sometimes, when the child is slightly feverish, the two elevations composing the summit may be of nearly equal size, and if the vaso-constriction be more completely removed, the second summit may be smaller than the first, but is still remarkably developed (Fig. 30). When the radial artery is felt to be contracted in this manner, the systolic wave is invariably rendered anacrotic, or is divided into a double summit, and should the vessel relax somewhat it is quite possible, as Graham Steell states, for the finger to appreciate the two summits of this wave. The writer has frequently known such a pulse called dicrotic. He can also confirm Steell's observation as to the development of this feature on one side of the body only; in carotid tracings it is not unusual to find that from the left side anacrotic, while that from the right side is normal—katacrotic.

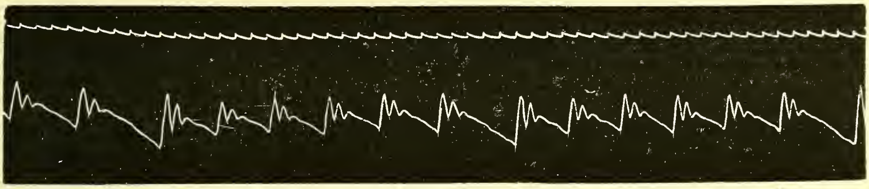

Fig. 30.—Pulse of child aged 5 years, suffering from tubercular meningitis. The peripheral arteries have become somewhat relaxed, and the usual anacrotic character of the curves has disappeared. The second summit of the systolic wave is still well developed. The type of pulse irregularity in this disease is well shown.

A very good example of the anacrotic pulse is shown in Fig. 31. It was obtained from a boy fourteen years old, who had extreme hypertrophy of the left ventricle and remarkable thickening of the arteries all over the body. It was with great difficulty that the pulse could be felt in the radial, or even in the brachial artery, and the presence of Raynaud's phenomena in the hands and feet suggested considerable obstruction in the peripheral blood-supply. The boy died from a cerebral hæmorrhage, the result, doubtless, of the excessively high arterial pressure. The whole arterial system was found to be uniformly thickened and contracted almost to the obliteration of the lumen in some of the smaller branches. The left ventricle showed pure concentric hypertrophy, and the aorta was greatly narrowed throughout its whole course. Here the peripheral resistance must have been enormous, and this was probably the factor mainly concerned in modifying the systolic wave in the manner described. Compression of the abdominal aorta will alter the systolic wave

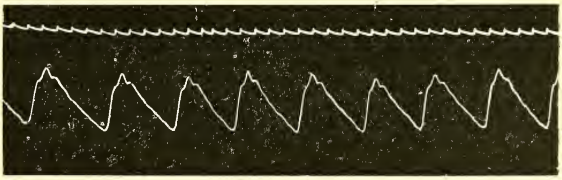

Fig. 31.—Very marked anacrotism of the pulse in a case where the peripheral resistance was enormously increased.

in a similar way, for a normal pulse-curve can by this means be made to exhibit anacrotic characters.

The anacrotic sphygmogram is sometimes a true representation of the course of events in the artery, but it may also be obtained by faulty application of the sphygmograph. Such a curve must often, for this reason, be regarded with suspicion as being possibly an incorrect record of the pulse under examination.

The Fontanelle Pulse.[1]—In the young child the brain, surrounded by fluid, is contained within the unyielding cranium. At one point there is a small area of elastic membrane—the fontanelle. The impulse of the left ventricle—systolic wave—is propagated to the arteries which ramify in the brain substance, and the whole organ expands. The fluid surrounding it is then compressed, and the membranous area is raised slightly. This is one of the fontanelle movements—the arterial—and it is really a plethysmographic pulsation. In this case the systolic wave is acting against great resistance, so the percussion element is largely abolished. This pulsation of the fontanelle is the expression of the more or less gradual swelling of the brain; and if a tracing be made by means of a system of tambours, a single slowly rising wave is often all that is obtained, or the curve may be slightly anacrotic (Fig. 32). But by means of more delicate apparatus, *e.g.* Dudgeon's or Marey's sphygmograph, the single wave can be broken up into a curve which is, as a rule, typically anacrotic. This is the normal form of intracranial pulse, and especially so when the general arterial blood pressure is high (Fig. 33).

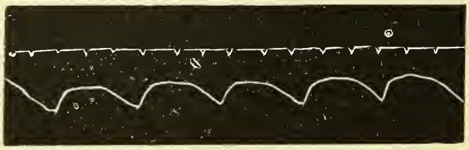

FIG. 32.—The fontanelle pulse taken by means of a system of tambours (rounded, slightly anacrotic curve).

Another movement of the fontanelle occurs with respiration. With inspiration blood is sucked out of the venous sinuses of the brain towards the right heart, and the volume of the brain is thus diminished. Hence the membrane is drawn inwards, and the arterial pulsations which occur during the inspiratory phase are of smaller size (Fig. 34). Exactly the opposite thing happens during expiration—distension of the brain and bulging of the fontanelle. With a high intracranial tension—bulging fontanelle—the respiratory undulations become less marked, while with a low intracranial tension—depression of the fontanelle—they are well developed.

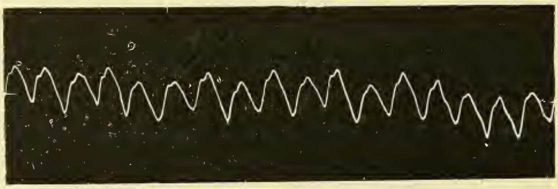

FIG. 33.—Fontanelle pulse from infant æt. 4 months, of typically anacrotic character. Normal form of intracranial pulse. (Dudgeon's sphygmograph.)

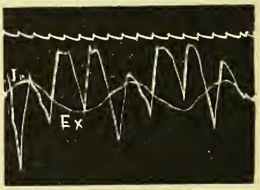

FIG. 34.—Simultaneous tracings of the respiratory movements and the fontanelle pulse to show the smaller arterial pulsations during inspiration, and the larger ones during expiration. (The intracranial tension was low.)

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[1] For fuller information on this subject the reader is referred to a valuable paper by Drs. Robert Hutchison and George Elder, *Ed. Hosp. Reports*, vol. iii. p. 268.

The Interpretation of Features due to Instrumental Defect.—Some of the features in the sphygmogram which we know not to be dependent upon true arterial waves may, nevertheless, be turned to good account. The *height* of the up-stroke made by the needle depends so much upon conditions and methods of applying the instrument that it has, as a rule, little significance. But in some instances, where a series of tracings is carefully made on the same patient when there is reason to believe that his radial calibre is undergoing daily variations, then the height of the up-stroke is of some suggestive moment. It will afford some indication of the state of *tonus* of the vessel. In the tightly contracted state the play of the arterial wall will certainly be much less than when the artery is fully relaxed. The writer has taken many sphygmograms to illustrate this point, and has confirmed the results obtained by measurements of the calibre of the radial artery by means of Oliver's arteriometer (Figs. 35 and 36). Tracings made under the influence of amyl-nitrite prove that the *height* of the up-stroke is sometimes a feature from which certain conclusions may be drawn.

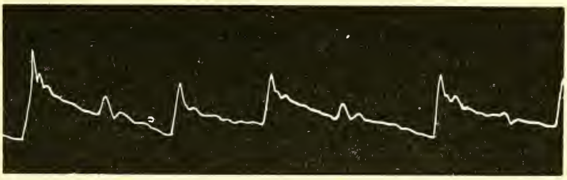

Fig. 35.—Sphygmogram from radial artery during an attack of dyspnœa with marked contraction of the peripheral arteries. Radial calibre 2·4 mm. Systolic wave slanting, blood pressure relatively high.

The *direction* of the up-stroke is of much greater importance. It may rise vertically—at nearly a right angle to the moving smoked surface; it may rise in a more slanting direction, or it may sometimes be distinctly bent inwards during its ascent.

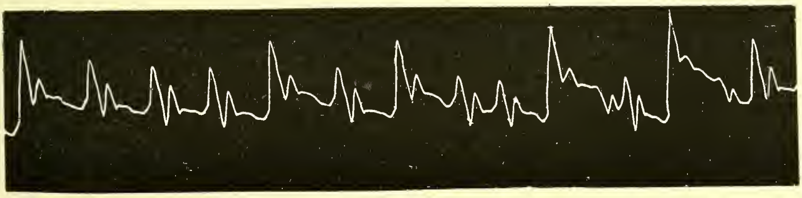

Fig. 36.—Tracing from the same case after treatment by nitrites, showing increased volume of pulse, larger and more vertical systolic wave; exaggerated dicrotism, especially in the abortive contractions of the ventricle Arteries are relaxed—radial calibre 2·7 mm.

A sudden rise of the needle indicates that there is a relatively strong ventricle, and that the distribution of the blood through the arterial system is unimpeded. This is seen in some cases of aortic regurgitation, and the systolic wave in such a tracing may have a double summit, and that of the first may be looped. The modification of the systolic wave in such cases is purely of instrumental origin—it does not imply co-existing stenosis. A similar summit may be obtained in any case where pyrexia has excited the ventricle and dilated the peripheral vessels. A distinguishing feature in the sphygmogram of aortic incompetence is the small size of the dicrotic wave and its position at the lowest part of the tracing (Fig. 37).

When a relatively strong ventricle is acting against some peripheral resistance the up-stroke of the tracing may also be sudden, but a smaller systolic wave is produced. The summit is again divided, and the first apex may be looped, acute, or rounded, while there is sometimes a considerable fall of the needle towards the abscissa before the second wave is developed. This second wave may be also unusually pointed owing to the inertia of the needle (see Figs. 30 and 38).

With a relatively weak ventricle and normal peripheral resistance, the up-stroke is apt to be more oblique; and if an instrumental apex to the systolic wave is formed, it is a small one. The up-stroke may be *incurved* where the ventricle is powerful, and the peripheral resistance increased. It is an instrumental defect (Fig. 39).

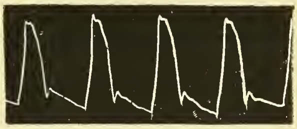

Fig. 37.—Pulse of aortic regurgitation. To show the small size of the dicrotic wave, and its position at the lowest part of the tracing.

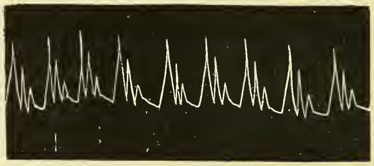

Fig. 38.—To show the kind of sphygmogram sometimes produced when a relatively strong ventricle is acting against considerable peripheral resistance. (Instrumental defect.)

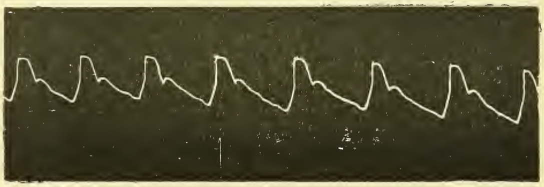

Fig. 39.—To show the incurved up-stroke—an instrumental defect.

With regard to the fall of the needle it may be said that a slow and even fall, with little prominence of the dicrotic wave, argues a relatively high blood pressure; a low pressure in the arteries is usually, but not always, distinguished by a rapid descent of the needle, and by a well-developed dicrotic wave. The excursion of the needle is generally greater when the blood pressure is low.

The Value of the Sphygmogram as indicating the State of the Blood Pressure.

(*a*) *The Position of the Dicrotic Notch.*—The question of blood pressure is only partially discussed by the behaviour of the needle of the sphygmograph. In forming an estimate of the arterial pressure from a pulse tracing, we should specially note the *position of the dicrotic notch* on the down-stroke of the curve. *The higher the position of this notch the higher the blood pressure.* Its height above the base line of the tracing is therefore an important point in deciding this question. The tracing, Fig. 40, was taken from the case already described, where great hypertrophy of the left

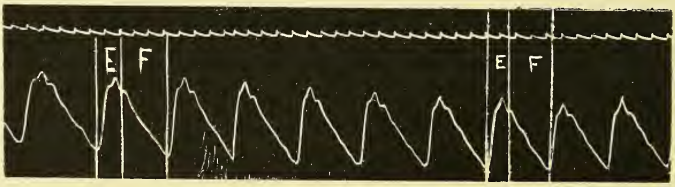

Fig. 40.—To show the high position of the dicrotic notch above the base line of the tracing. Indicates a high arterial blood pressure. E, systole of ventricle; F, diastole of ventricle.

ventricle co-existed with general thickening and narrowing of the arteries (see page 207). The height of the blood pressure in this instance must have been exceptional, and it is interesting to note the remarkably high position of the dicrotic notch above the base line of the tracing. The low position of the notch in aortic regurgitation may be usefully compared with this (see Fig. 37).

(*b*) *The Character of the Dicrotic Wave.*—This is also suggestive. If the dicrotic wave has been absent or very small in a sphygmogram of the low-pressure type, and gradually becomes more developed, we may safely affirm that the arterial pressure is increasing. Conversely the gradual disappearance of the dicrotic wave in a case of this kind denotes that the blood pressure is falling to a dangerously low point. From a tracing of this type, if it persist, one may most always prognosticate a fatal issue, and in the pneumonias of young children the writer has not so far found a single exception to this. A tracing is appended to illustrate this type of pulse from a child dying of broncho-pneumonia (Fig. 41).

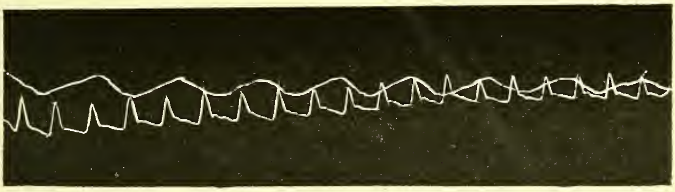

Fig. 41.—Pulse and respiration in a case of fatal broncho-pneumonia. Child æt. 1¾ years. To show the disappearance of the dicrotic wave—blood pressure dangerously low.

Should an increase in the blood pressure occur in a case of this kind, the first indication is the appearance of a dicrotic wave. Therefore this can always be regarded as a reassuring sign. In the rapidly dilating heart of pneumonia and acute rheumatism in children, it has been elsewhere pointed out that the most significant and striking symptom is often the disappearance or great diminution of the dicrotic wave. A case of extreme rheumatic dilatation in a young child showed this feature when first examined, and there was also epigastric pulsation. After a few days' rest in bed, recovery was indicated by the reappearance of the dicrotic wave in the pulse-curve, and by the disappearance of epigastric pulsation.

(*c*) *The Significance of the Dicrotic Wave.*—The presence of the dicrotic wave indicates that there is some degree of arterial pressure, for the pressure must be excessively low when the recoil wave is not sufficiently powerful to be reflected from the aortic valve. The summit of the dicrotic wave is usually less pointed than the systolic wave.

Dicrotism and Hyperdicrotism.—In the so-called dicrotic pulse the dicrotic notch bears a certain relationship to the base line of the trace. If it descend to the base line before the dicrotic wave is developed, the pulse is sometimes called *fully dicrotic.* Should the notch occur below the level of the abscissa the pulse is said to be *hyperdicrotic.* This may occur to such a degree that the dicrotic wave runs into the up-stroke of the next beat. The

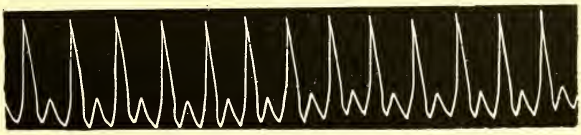

Fig. 42.—Typical dicrotic pulse (enteric fever, 20th day).

rate of the pulse, combined with increased inertia of the needle, plays a very large part in the production of this exaggerated dicrotism. Hyperdicrotism is always associated with great frequency of the pulse, and with a general relaxation of the vessel (Figs. 42, 43, and 44).

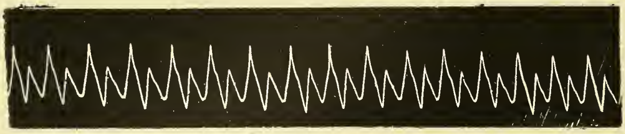

Fig. 43.—More fully developed dicrotism.

The Monocrotic Pulse.—It is somewhat difficult to decide upon the form of pulse-curve to which this term may be correctly applied. The usual definition of a monocrotic pulse is one in which the dicrotic wave is absent. The sphygmogram shows a series of single curves, but in some of these the position of the dicrotic notch is indicated either by a break towards the end of the down-stroke, or by a slight rise which appears just before the commencement of the up-stroke (Fig. 45). A monocrotic pulse, in its literal sense, means a pulse which shows only one distinguishable wave. But there are certain fallacies to be noted.

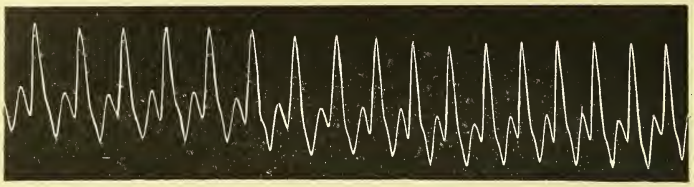

Fig. 44.—Hyperdicrotism of the pulse. This is largely the result of increased inertia of the needle of the sphygmograph and extreme rapidity of the pulse.

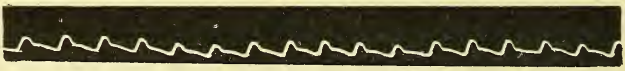

Fig. 45.—*Monocrotic* pulse (disappearance of dicrotic wave) in fatal case of puerperal septicæmia.

In the case of very young infants, and also in older children, the sphygmogram sometimes appears as a single undulation (Fig. 46). Hence the pulse at this period of life has been called monocrotic, and this would seem to be compatible with the low blood pressure of the infant (Ozanam, Keating and Edwards, and others). By the use of more delicate instruments, however, the infant's pulse is found, in reality, to be of the type which is associated with a *relatively* high blood pressure in the arteries.

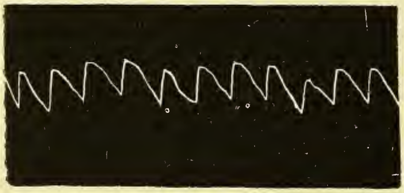

Fig. 46.—Pulse of infant aged 10 months, showing one wave (erroneously called *monocrotic*).

Again, when the arterial pressure is low and the pulse rapid, the dicrotic wave may be developed to such an extent that it nearly equals the size of the systolic wave. Such a tracing as Fig. 47, where the diastolic phase of the ventricle is hardly apparent, might be mistaken for a monocrotic pulse.

Speaking of the monocrotic pulse, Mahomed said: "A monocrotic pulse is merely a hyperdicrotic pulse, which is so rapid that the primary up-stroke becomes superimposed upon the dicrotic wave, which has not time to travel to the radial before the more rapidly transmitted primary wave of the succeeding cardiac contraction overtakes and absorbs it, as one often sees a small wave of the sea merged into the larger one which has overrun it."

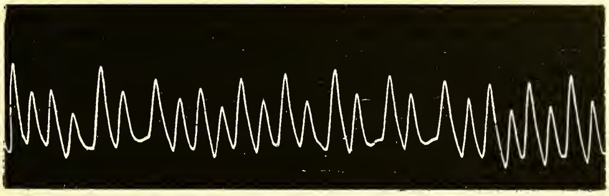

FIG. 47.—Another form of pseudo-monocrotic pulse. The dicrotic wave is greatly exaggerated.

In a very rapid hyperdicrotic pulse we have observed this for a few beats at a time (see Fig. 45), but in such a case the *dicrotic wave* is *not* really *absent*, nor is the blood pressure excessively low; the mere rate of the pulse has led to the production of monocrotic curves. It might be advisable to limit the term "monocrotic pulse" to those cases in which the single elevation is the result of *the disappearance of the dicrotic wave.* A sphygmogram of this type is of evil omen, because it denotes extreme lowering of the blood pressure; the hyperdicrotic form, which becomes monocrotic, is only significant of danger on account of its great rapidity.

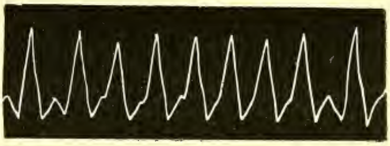

FIG. 48.—Hyperdicrotic pulse becoming monocrotic from increased rapidity.

THE SPHYGMOGRAPHIC APPEARANCES OF THE PULSE IN INFANCY

The radial artery of the new-born infant is very small, and cannot be felt as a definite structure. The vessel is situated rather deeply in the tissues of the wrist, and there is often a large quantity of subcutaneous fat around it.

Ozanam, Keating and Edwards, and others, have described the sphygmogram from the new-born infant as a meaningless wavy line (Fig. 49). From the absence of dicrotism they conclude that the arterial pressure is very low, and regard the pulse as monocrotic. These authors hold that the conditions necessary for the production of the dicrotic wave are absent in early life. These conditions, they say, are elasticity of the great vessels combined with low tension of the peripheral

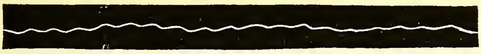

FIG. 49.—Pulse of the new-born infant (Ozanam). (Incorrectly called *monocrotic.*)

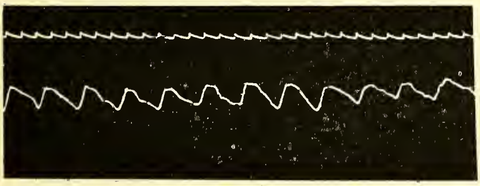

FIG. 50.—Pulse of an infant after ligature of the umbilical cord. (Indicates a relatively high blood pressure.)

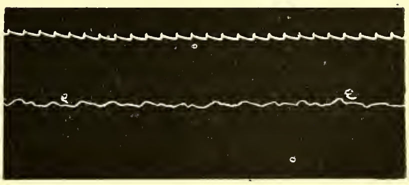

FIG. 51.—Tracing from the posterior tibial artery of a fœtus. (Shows the dicrotic notch *e.*)

circulation, and a sharp contraction of the heart. In the infant they believe that owing to the relatively less strong heart the arteries are not distended to such an extent as to cause a thorough recoil, and, further, that there is a marked resistance to the peripheral circulation in the kidney.

The writer's tracings from the pulse of infants do not show an absence of dicrotism, and the pulse-curve does not indicate a low arterial pressure. Sphygmograms made in the manner already described show clearly that the pulse of young infants is of the type associated with a *relatively* high blood pressure (Figs. 50, 52, and 53). Dicrotism is as marked in the sphygmogram of the new-born infant as it is in any high pressure pulse.

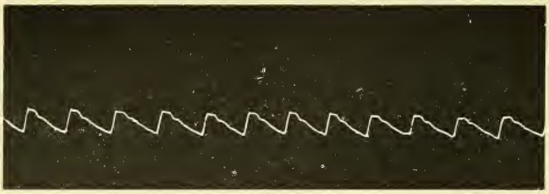

Fig. 52.—Pulse of a normal infant 6 days old. (Indicates a relatively high arterial blood pressure.)

A tracing was obtained from the posterior tibial artery of a fœtus during the process of "turning," and in it the position of the dicrotic notch is clearly indicated (Fig. 51). Even before birth, then, the pulse-curve would seem to be marked off in this way into systolic and diastolic portions, when we employ suitable means of instrumental examination.

The sphygmogram shown in Fig. 52, which was taken from a healthy boy six days old, brings out clearly all the features which characterise a high-pressure pulse-tracing in an adult. The systolic wave rises in a slanting direction, and the dicrotic notch occupies a high position on the down-stroke. The instrumental division of the systolic wave into two summits is just apparent in some of the curves, but in the tracing, Fig. 53, from an older child it is very well marked.

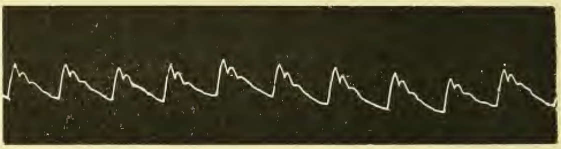

Fig 53.—Pulse of child aged 4 months. To shew the division of the systolic wave into two summits.

To find the explanation of this high-pressure type of curve, which is characteristic of the very young infant, attention may be directed to the striking resemblance which exists between it and that obtained in aortic stenosis in the adult. The tracing from a premature infant, and some which I have taken from babies a few hours after birth (Fig. 54), compare equally well with those from a case of aortic stenosis, and perhaps still better with the type obtained from some cases of aneurysm affecting the arch of the aorta. The analogy to the latter is a specially apt one, because the conditions giving rise to this form of pulse-wave in both instances are

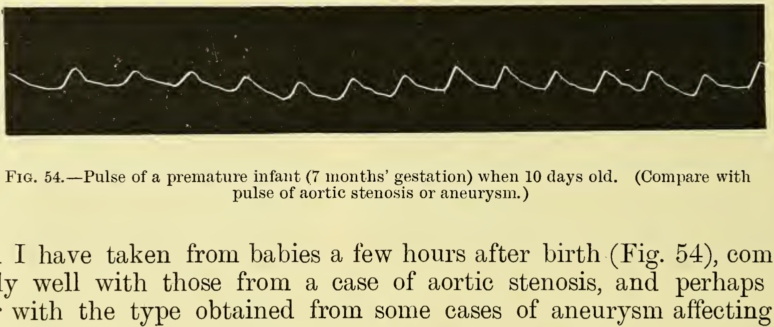

Fig. 54.—Pulse of a premature infant (7 months' gestation) when 10 days old. (Compare with pulse of aortic stenosis or aneurysm.)

remarkably similar. We refer to the relation which exists between the size of the heart and the width of the aorta, and also to the fact that there is relatively less blood in the arterial system, and hence a smaller pulse at the wrist. Beneke has shown that the volume of the infant's heart is to the width of its ascending aorta as 25 : 50, whereas before puberty it becomes as 140 : 50. There is thus in both conditions a left ventricle connected by a narrow opening with a relatively capacious aorta. On this account the ventricular contraction is slowly developed, and the "shock" imparted to the column of blood at the root of the aorta is more slowly propagated throughout the arterial system than it is under normal conditions. The "systolic wave" is thus modified in much the same manner as it is in the fontanelle pulse, and rises in a sloping direction instead of being a vertical line. The features of a high-pressure pulse are thus delineated in the tracing from a new-born infant for the same reasons that they are reproduced in aortic stenosis or aneurysm in the adult.

Until the end of the first year of life the infant's pulse remains as this high-pressure type, but after a few months the systolic wave is more distinctly divided into a double summit, and the volume of the pulse increases.

It is interesting to note the effects of pyrexia on the pulse of infants under a year old; a high degree of fever at this age does not render the pulse dicrotic or hyperdicrotic (Fig. 55). In adults the form of pulse-curve is very readily altered by even slight elevations of temperature, and varying degrees of dicrotism are produced. In children under one year old it is most unusual to obtain a pulse-tracing which shows a well-marked dicrotic wave, either as a result of pyrexia or from any other cause. At this age a dicrotic pulse is occasionally found in broncho-pneumonia, where the blood pressure is extremely low.

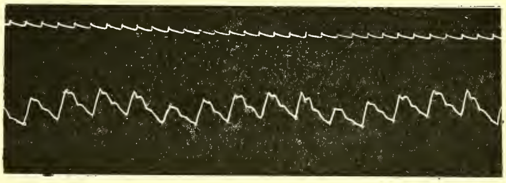

Fig. 55.—Pulse of a child æt. 11 months ; temp. 105°. (Dicrotism has not been produced.

Pulse Irregularity

Introduction.—Perhaps nothing strikes one so much in the study of the pulse as the frequent occurrence of irregularity. Children will sometimes exhibit a remarkable form of pulse, which it is difficult to reconcile with perfect health, and yet there is often no indication of disease. The peculiarity of the pulse-rhythm may be of a very transient nature, or it may be present over a considerable period. It may be noticed in the infant at birth, or soon afterwards, when the pulse-rate is unusually slow; this kind of irregularity disappears when the pulse becomes rapid.

The pulse-wave increases in strength and volume from birth to puberty, and the increase in size of the radial artery is proportionately greater than the growth of the hand. The *rate* of the pulse of the young infant, if carefully observed, will be found to vary enormously. When a child is kept in bed for a considerable period the pulse invariably slows down in a striking manner, and the same thing is noticed after a febrile attack. Under the influence of a high temperature the pulse will be very greatly accelerated, but after the fever subsides the rate becomes abnormally slow, and, at the same time, there is a tendency to irregularity of rhythm.

During sleep the same type of slow, irregular pulse is often found. After the third year of life there is a notable diminution in the rate of the pulse. Great frequency of the pulse in young children has much less significance than in adults. The enormous rapidity at the commencement of a scarlatinal attack is sometimes striking, and in the later stages of tubercular meningitis a peculiar irregularity in a very rapid pulse is worthy of note—the number of beats counted in separate quarter minutes is found to vary remarkably.

Persistent slowness of the pulse in early life is unusual, and may suggest cerebral disease. But in ill-nourished, marasmic babies great slowing of the pulse is sometimes observed, and this symptom has been noted in cases of sclerema neonatorum. Catarrhal jaundice in children under six or seven years of age does not appear to produce a slowing of the pulse-rate, at least not to such a marked degree as is observed in adults.

The *rhythm* and *character* of the pulse are frequently of very great value. In the acute pneumonias of young children, if sphygmographic records be made throughout the course of the disease, important conclusions may be formed as to the favourable or unfavourable progress of the case, and of the good or bad effects of treatment.

A slow, irregular pulse is specially characteristic of cerebral tumour, abscess, or hæmorrhage. In children under two years of age suffering from tubercular meningitis, the writer believes the peculiar retardation of the pulse in the early stages of the disease is rarely observed. When it is present it is probably a very transient phenomenon. So far as his experience goes in these cases, the pulse at this age is generally very rapid from the time the child first comes under examination. But in tubercular meningitis in older children there is sometimes a type of irregularity which may be of some diagnostic value.

Classification of Pulse Irregularities.—Pulse irregularities have been classified in various ways, none of which are altogether satisfactory. There has been much misconception of the symptom, because writers have drawn distinctions between the terms "intermittency" and "irregularity" in connection with the subject. Such a distinction is in reality a purely artificial one, as will be afterwards shown. A pulse can only be called "*intermittent*," in the true sense of the word, when a whole heart-beat is, from time to time, entirely missed out, that is to say, the ventricle remains in a state of diastole for *exactly two ordinary pulse intervals*, and makes no attempt to contract during that time either prematurely or otherwise. This condition of matters certainly does not seem to occur in children, so we may dispense with the phrase "intermittent pulse" in connection with the pulse irregularities observed during early life. Cushny, in an interesting paper on intermittent pulse, has attempted to classify the common types of irregularity which occur in adults on the basis of cardiac physiology. In animals, by stimulation of the auricle and ventricle respectively, he has been able to produce and distinguish two main forms of pulse irregularity or intermission. The first is due to ventricular failure, and the second to auricular.

It will be necessary to shortly summarise his conclusions in order to be in a position to deal adequately with the subject of pulse irregularity.

The classification suggested by Cushny is worked out by observing what occurs in the behaviour of both the auricle and the ventricle during the so-called intermission in the arterial pulse. Now, clinically, it is only in exceptional cases that we have the opportunity of recording the auricular contractions. Dr. James Mackenzie has studied this subject in a most thorough and admirable manner, and by recording the pulsation of the jugular vein simultaneously with the radial pulse, he has shown clearly what the right auricle is doing during the irregularity of the left ventricle. The left auricle, he concludes, in all probability acts similarly to the right one. The behaviour of the right ventricle he has also determined, in many cases, from graphic records of the pulsation of the liver or jugular veins, and he is led to believe that hemisystole of the heart does not occur. According to his numerous and highly reliable observations, the right ventricle does not act independently of the left, or very rarely so. Mackenzie has also shown that the auricles may retain their regularity without the ventricles necessarily following suit. That is to say, the ventricles may for some reason contract *prematurely* before the normal period of their diastole is finished, and the next auricular contraction will still come in at its proper interval after the preceding one. Under such circumstances the ventricle will not respond to this auricular contraction, but will wait for the next one.

In the majority of cases where we find pulse irregularity, we have to determine its nature by an examination of the *left ventricle* alone. It is seldom that the behaviour of the other chambers of the heart can be observed unless the case be one of advanced cardiac disease. Therefore it will be well, clinically, to classify pulse irregularities according to what is revealed by a combined examination of the arterial pulse and the apex beat. The cardiograph must in some cases be used to make a simultaneous record of the left ventricular movement, or, in some instances, the simpler method of listening to the cardiac sounds may be adopted.

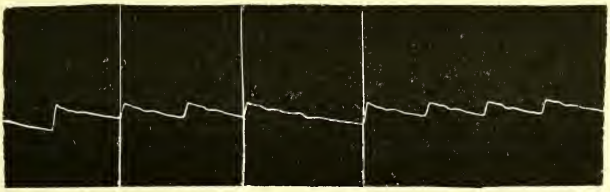

Fig. 56.—The "intermission" is equal to two pulse-intervals (Cushny s classification).

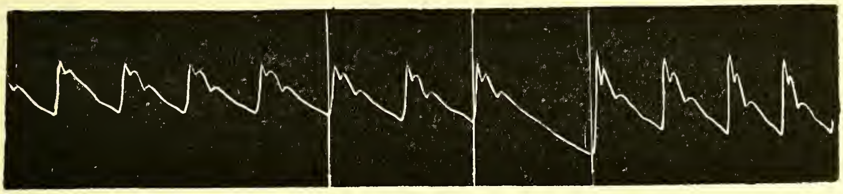

Fig. 57.—The "intermission" is *less* than two pulse-intervals (Cushny's classification

Cushny's Classification of Pulse Irregularities.—Cushny recognises two *main* forms of pulse-intermission—

(1) Those in which the intermission is about equal to two pulse-intervals (Fig. 56).

(2) Those in which the intermission is shorter than two pulse-intervals (Fig. 57).

He describes *two varieties* of intermission belonging to each of these classes, and his classification is as follows:—

I. *True ventricular intermissions,* in which the pause is exactly equal to two pulse-intervals, and during which there is no cardiac sound.

In the human subject this is certainly a very uncommon form, and very great discrimination would sometimes have to be exercised in deciding whether such a tracing should not properly be relegated to the next division. The supposed "dropped" beat may not really occur, for the premature contraction of the ventricle may be too feeble to show an elevation in the sphygmogram. The following is Cushny's description of what happens in animals:—

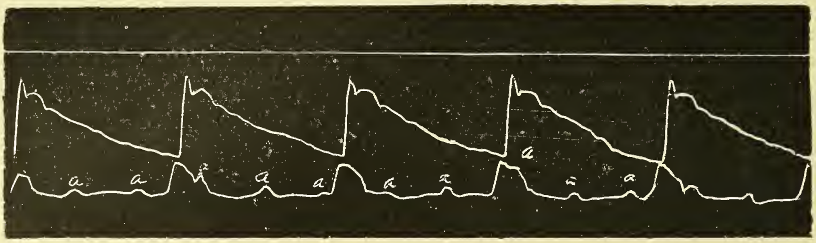

FIG. 58.—"True ventricular intermission." The lower tracing is from the jugular vein, and gives the auricular movements (a=auricular systole). (Cushny's classification.)

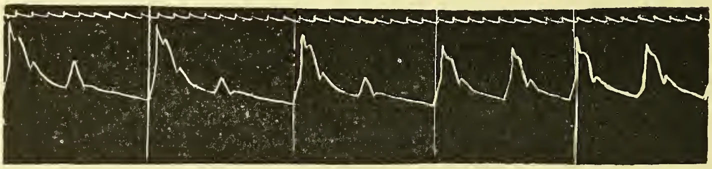

FIG. 59.—"False ventricular intermission." The "intermission" is equal to two pulse-intervals, but an elevation (*premature systole*) occurs during the pause. (Cushny's classification.)

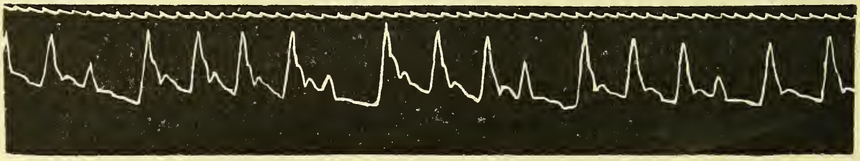

FIG. 60.—"False ventricular intermission." The ventricle has made a second and premature contraction (p) after its full beat. (Cushny's classification.) The last intermission shown in the tracing may be of the "false *auricular*" type (see page 219).

The auricular contractions occur at regular intervals, and the ventricles usually respond. But occasionally the impulse emitted from the auricle in regular course is not followed by a ventricular contraction. For some reason the ventricle does *not* contract, and thus a whole heart-beat is entirely missed out. The ventricle contracts in response to the next auricular impulse, but the *cause* of the intermission in this case lies with the *ventricle* itself, and not with the auricle, which sent down its impulse as usual. When this occurs, then, we may correctly describe it as a "true ventricular intermission."

The writer has only seen one tracing where this form of pulse irregularity could actually be shown to occur. He obtained it from Dr. Mackenzie of Burnley, who regards it as an almost unique example of the so-called *true* ventricular intermission (Fig. 58). Mackenzie believes that in the vast majority of intermittent pulses in adults, the ventricle really makes a second attempt to contract during the long pause, but that the effect on the circulation is not made manifest at the radial artery. In the true intermission referred to, it is seen that the ventricle did not always respond to the auricular stimulation. A simultaneous tracing obtained from the internal jugular vein recorded the auricular movements. The venous tracing is somewhat difficult to interpret, but there is no doubt that the auricle contracts *twice* or *thrice* for each ventricular beat.

II. *False ventricular intermissions,* in which the pause is equal to two pulse-intervals, but it is often interrupted by a slight elevation.

In every case a first heart sound is to be heard during the intermission.

In this form, as in that just described, the auricle still contracts at regular intervals, and often the ventricle follows suit in the proper way. But sometimes the ventricle is unduly irritable, and is stimulated to contract from other causes than an auricular impulse. Therefore, after having given its usual contraction in response to the auricle, it goes off a second time during the period in which it should be resting and preparing to receive the next stimulus from the auricle. In doing so it exhausts itself, and is unable to contract when the auricular impulse descends. The diastolic period is therefore prolonged until the next auricular beat occurs (Figs. 59 and 60).

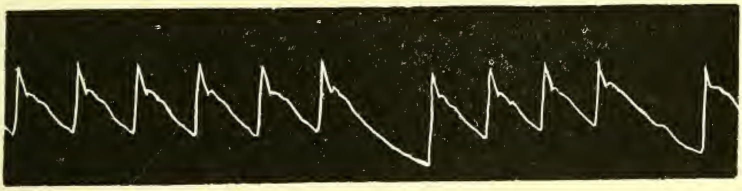

Fig. 61.—"True auricular intermission." The "intermission" is *shorter* than two pulse-intervals, and there is no second contraction of the ventricle during the pause. (Cushny's classification.)

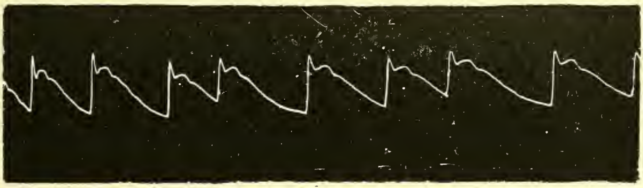

Fig. 62.—Pulse of child æt. 5 years, showing irregularity of the "true auricular" type, according to Cushny's classification.

III. *False auricular intermissions,* in which the pause is shorter than two pulse-intervals.

There is a slight elevation in the tracing during the intermission, and the stethoscope reveals a first heart sound very soon after the last regular pulse elevation.

This type of irregular pulse is very similar to the false ventricular intermission, but according to Cushny measurement in this case shows that the full beat and the premature beat are of *shorter* duration than two ordinary pulse-intervals. By this means he would diagnose the occurrence of this variety in man. It is probable that the false ventricular intermission is commonly mistaken for the auricular form, and measurement would not seem to be a reliable method of distinguishing the one variety from the other. The only *certain* method, as Mackenzie points out, is to obtain a record of the auricular movement from the jugular pulse. This is only possible in the few instances in which venous pulsation is coincidently present, so as a general rule the "false auricular intermission" cannot be definitely diagnosed. In this variety the auricle contracts prematurely and the ventricle follows suit; the regular contractions of the auricle are thus broken—hence the *cause* of the irregularity lies in the *auricle* and not in the ventricle.

IV. *True auricular intermissions,* in which the pause is shorter than two pulse-intervals, and during which there is no cardiac sound (Figs. 61 and 62).

In this variety, unlike the last described, the auricle instead of going off into a premature contraction at various intervals, does not contract at all. For some reason the sequence of regular auricular impulses to the ventricle is broken, and after a longer pause than usual the next contraction comes and is followed by the ventricular systole. Cushny calls this a true auricular intermission, but a study of the child's pulse shows it to be of such common occurrence in early life that another explanation is more likely. This kind of intermission is found in adults, but it only occurs at very rare intervals (see Fig. 57), whereas in the case of the child it occurs all through the tracing. The writer may also state that in adults who exhibited this peculiar irregularity, he could never make out other heart sounds after the regular contraction; the ventricle may, nevertheless, have made an attempt at premature contraction. Still there is no reason why, in both adults and children, this form of pulse should be regarded as an intermission at all. There is no real *intermission* of the heart—that is, as a beat *lost;* it may be more simply and more correctly described as a beat *delayed.*

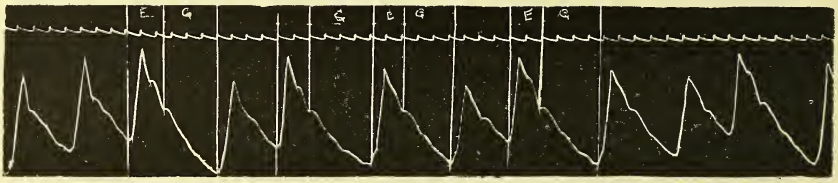

Fig. 63.—Pulse of child æt. 4½ years. E, The duration of the period of ventricular *systole* is *regular;* G, the duration of the period of ventricular *diastole* is *variable.* "*Youthful type o irregularity*" (Mackenzie's classification).

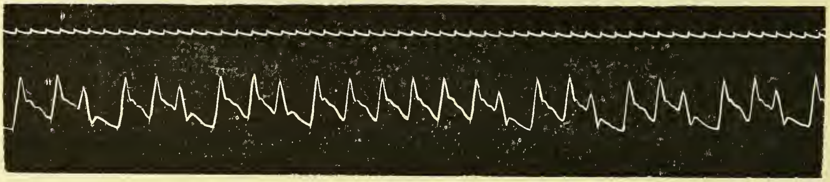

Fig. 64.—"Adult type of irregularity" (false ventricular intermission) occurring in a child æt. 2 years during the course of a mild croupous pneumonia. (Mackenzie's classification.)

These four types of pulse intermission described by Cushny may be obtained experimentally on animals, but, clinically, if we adopt his nomenclature, there are only two common variations which we need consider, namely, the so-called *false ventricular intermission,* and the *true auricular* one. The true auricular intermission of Cushny is the one form of irregularity which is very frequently found in children.

Mackenzie, who has investigated the subject of pulse irregularity from the clinical side in an exhaustive manner, adopts a much simpler and more useful classification. He admits the two common types which have been mentioned; the so-called false ventricular and the true auricular intermissions. The two other forms of irregularity described by Cushny apparently do exist, but one has not often the opportunity of confirming the auricular contraction in cases of doubt.

Mackenzie's Classification of Pulse Irregularities.—Mackenzie, in his classification of irregularities of the pulse, suggests two groups—

I. Those in which the duration of the period of ventricular *systole is regular.* The irregularity is here shown by the varying lengths of the diastolic periods (Fig. 63). This is the type observed so often in the young, and is what Mackenzie terms "the youthful type of irregularity." It occurs in adults too, however, and is evidently the same thing as Cushny has described as a true auricular intermission.

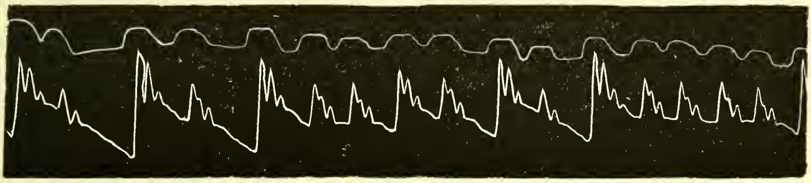

FIG. 65.—The duration of the period of ventricular *systole* is *variable*—the upper tracing is a cardiographic record. "Adult type of irregularity" (Mackenzie's classification). This is the "false ventricular intermission" of Cushny.

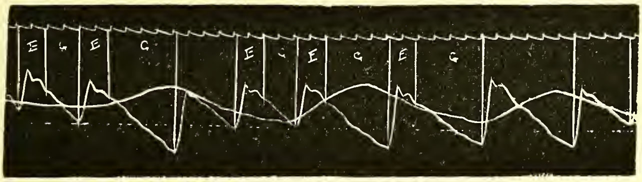

FIG. 66.—The characteristic type of pulse irregularity in a child æt. 6 years, with simultaneous tracing of respiration. Duration of systoles (E) are regular. Duration of diastoles (G) are variable. It may be noted that the irregularity is here independent of respiratory causes (see page 223).

II. Those in which the duration of the period of ventricular *systole is variable.* This is the usual type in adults, and has been supposed never to exist in young children. The writer has, however, found it on several occasions, the youngest child being only two years old (Fig. 64). It may occur also in older children who suffer from advanced cardiac disease. This is the same form of irregularity as Cushny describes under the head of false ventricular intermission (Fig. 65).

According to Mackenzie's classification, then, we find that practically all the pulse irregularities met with in children fall into the first group, while the commonest type of adult irregularity belongs to the second group.

Such a method of classification has done much to simplify the study of this interesting subject, but there are many kinds of pulse irregularity in children which have hitherto received no attention. Respiration is a most important factor in the production of some of these.

The Characteristic Type of Pulse Irregualrity in the Child.—All children at some time or other exhibit a form of pulse irregularity. When a tracing is taken the precise nature of the irregularity is well shown, and it is found that the systolic portions of the pulse-curves are regular in their duration. If we measure with a pair of compasses from the middle of the up-stroke to the dicrotic notch, we find the length about the same in all the curves. If we measure in a similar manner from the dicrotic notch to the commencement of another up-stroke, we find the distances to vary considerably. In the child's pulse, then, as Mackenzie first pointed out, the *equal duration of the systolic periods* is much the most constant feature, while very frequently *the diastolic periods are of unequal length* (Figs. 66 and 67).

In the very rapid pulse the duration of the ventricular systole is not much shortened; it is at the expense of the diastolic period that things are balanced. Thus we can understand that when a child's pulse is very fast the diastolic phases tend to shorten, and hence this type of irregularity disappears more or less entirely. In a tracing of a very rapid pulse one can easily observe the relatively greater duration of the systolic portions of the curves, and the diastolic portions are reduced to a minimum. The converse of this is true, for when the rapid pulse begins to slow down again we generally find undue prolongation of the diastolic periods, and there is no very marked change in the duration of the systolic periods.

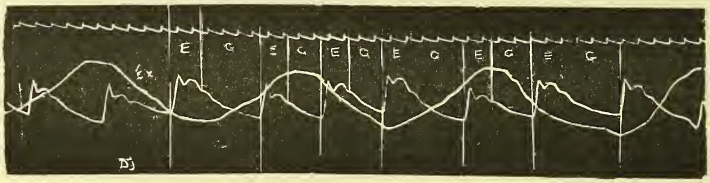

FIG. 67.—The characteristic type of irregularity in a child æt. 4 years. Systolic periods (E) equal; diastolic periods (G) unequal. The shorter pulse-beats would seem to occur during the *inspiratory* part of respiration (see page 223).

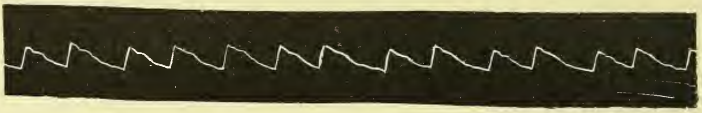

FIG. 68.—Sphygmogram taken from the leg of a young dog to show the "youthful type of irregularity"; is probably due to respiration.

The pulse generally becomes slower during sleep, and then the occurrence of this kind of irregularity can often be noted. When the child wakes the pulse tends to become faster, and thus becomes more regular. The pulse of the new-born baby is, as a rule, very rapid, and irregularity of the kind mentioned is not usually seen. But should the pulse become temporarily slower the prolonged diastolic phases will soon make their appearance. This is a common type of pulse irregularity in animals (Fig. 68).

As the child grows older there is a *natural slowing* of the pulse. It is probable that the physiological inhibition of the heart is not fully developed in early infancy, hence the great frequency of the beats during the first few months of life. It has been found that stimulation of the vagus has not the same restraining influence upon the heart-beats in infants that it has in adults. Therefore we may find the explanation of this peculiar pulse irregularity, which is certainly most strikingly developed at the time when the pulse is naturally slowing down after infancy, in the fact that the vagus is beginning to exert more decided control over the heart.

The Causes of Pulse Irregularity in Children.—This type of pulse irregularity in its most marked form would certainly appear to be a purely nervous phenomenon. Cushny calls it a "true auricular intermission." He says the emission of the impulse from the auricle to the ventricle is, for some reason, *retarded*. The ventricular rhythm is dominated by the auricular, so the ventricle must wait till the impulse descends to it. There is no reason, he points out, why the auricular contraction should be retarded for a whole cycle, and, as a matter of fact, it almost always occurs shortly after its proper time. This is quite an exact description, but the writer does not consider that it is either necessary or advisable to speak of this frequent *halt* in the pulse as an *intermission*. A whole heart beat is not missed out, and he cannot agree with Cushny that the *auricle* is the controlling influence in the production of the irregularity. In animals it may be so, and perhaps also in adults, where an intermission which might be of this nature occurs at very rare intervals, during which no cardiac sounds can be heard.

In children, at all ages, the writer has made very numerous observations on this type of pulse irregularity, and the matter has been studied from various points of view.

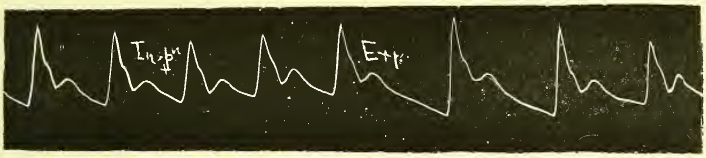

FIG. 69.—The longer pulse-beats (lengthened diastolic periods) occur during expiration. The vagus is here regaining its influence over the heart (*over-action*), after the transient loss of control at inspiration (quickening of the pulse).

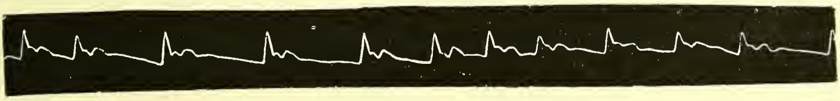

FIG. 70.—Pulse irregularity due to vagus influence. Boy æt. 9 years, under the action of digitalis.

The Influence of Respiration on the Pulse-Rhythm.—By taking simultaneous records of the pulse and respiratory curves, it has been possible to note the effects of inspiration and expiration on the form and duration of the pulse-wave. The movements of inspiration and expiration in the child apparently influence the radial pulse in a more marked manner than is generally appreciated, and to a greater degree than is usually observed in adults. By deep respiratory movements there are great alterations produced in the quantity of blood reaching the medulla. Diminished or increased blood pressure in the vessels of the medulla will lead to depression or stimulation of the various centres resident there, and thence to the development of certain effects on the heart and blood-vessels. We do not mean to assert that the youthful type of pulse irregularity is *always* or even *usually* due to the influence of respiration on the vagus centre, but in many cases the pulse tracing may show a distinct respiratory rhythm of this nature (see Fig. 67). We would go the length of saying that respiration, either directly or indirectly, is intimately associated with the production of the so-called youthful type of irregularity. In some instances, however, it is difficult to see how it participates, for when a child holds its breath the irregularity is still as marked as ever, and in other cases one finds both the usual form of irregularity and also another, which is clearly due to respiration.

The Influence of the Vagus.—This youthful type of pulse irregularity is by no means uncommon in young adults of nervous temperament. Perhaps the pulse, when first examined, becomes unduly rapid, and the vagus control is temporarily overbalanced. As the vagus begins to regain its influence a slowing of the pulse occurs, and then its halting, hesitating character becomes apparent. We, therefore, believe that this form of irregularity is largely the result of *over-action on the part of the vagus.* Such over-action may, of course, be dependent on many causes, among which respiration has already been mentioned as one of the most constant and important. An over-acting vagus produces the retardation noticed in some of the pulse-beats, or, in other words, results in the occasional *delay* of a systolic contraction (Fig. 69). Under the action of digitalis a pulse irregularity of this kind is often produced (Fig. 70).

In the youthful type of irregularity the diastolic period is sometimes so much prolonged that the whole pulse-curve, if measured, may be found equal to, or even greater than, two ordinary pulse intervals. But a second heart-beat does not really occur in this form of irregularity.

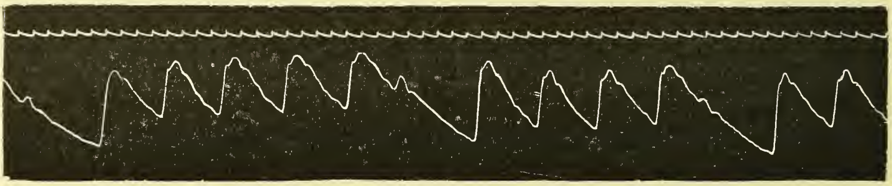

Fig. 71.—The "pulsus bigeminus" of Traube. Male patient æt. 64, suffering from advanced arterio-sclerosis—peripheral resistance enormously increased. ("False ventricular intermission"—Cushny.)

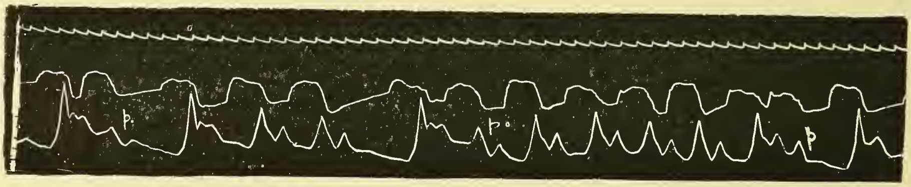

Fig. 72.—The "pulsus bigeminus, with a simultaneous cardiographic record, to show the two ventricular contractions corresponding to the full pulse-beat and the premature beat (*p*). ("False ventricular intermission.")

Some Conditions where this Type of Pulse Irregularity occurs.—The conditions favouring the appearance of irregularity in children are:—

(1) Rest in bed.
(2) Slowing of the pulse after fevers.
(3) During certain diseases—chorea, tubercular meningitis, etc.
(4) During respiration.

Possible Subdivision of the Youthful Type of Pulse Irregularity.—The irregularity in all these cases is very similar, but the writer is disposed to think that certain distinctive features mark that form which is dependent on respiration. In the usual type of irregularity, which is *not* due to respiration, the diastolic periods are sometimes lengthened, and are sometimes markedly shortened. Short beats follow long beats all through the tracing without maintaining any definite order. In the respiratory irregularity the diastolic periods are almost invariably lengthened during the expiratory phase, and are sometimes shortened during inspiration. When such a tracing is examined a more regular type of irregularity is apparent—there is some method in the arrangement of the long and short beats. It is therefore possible to make a *subdivision of the youthful type* of pulse irregularity:

(1) Those which are due to the influence of respiration;

(2) Those which are *not* due to the influence of respiration.

Description of the Bigeminal Pulse and some of its Modifications.—We have already indicated what is the special feature of the adult type of irregularity. We may now, however, add something more. Traube described this form as the *pulsus bigeminus* or bigeminal pulse (Fig. 71), and believed the second and smaller beat to be due to an exaggerated dicrotic wave. A simultaneous tracing of the left apex-beat entirely disproves this idea (Fig. 72). It is then clearly demonstrated that two ventricular contractions follow each other in rapid succession during the time occupied by the prolonged pulse interval. The little upheaval, marked *p* in the tracings, is really a second and *early* systolic contraction, and is followed by a long diastolic period. This so-called *premature systole* (*p*) may be represented in the tracing by a very small or by a relatively large wave. In some cases, when the second systole is not sufficiently strong to raise the aortic valves, the elevation is absent altogether, and then the line of descent of the tracing falls steadily to the abscissa. In such a case it may very easily be mistaken for the so-called "true ventricular intermission," where the ventricle misses out an entire beat, but the cardiograph or stethoscope will decide the question. The occurrence of this type of irregularity in children is excessively rare, still it is sometimes met with.

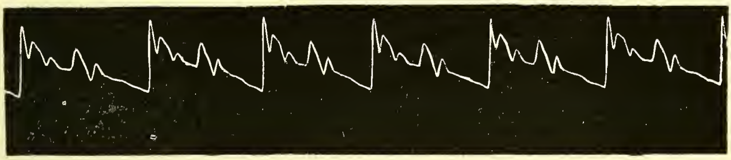

FIG 73.—"Pulsus alternans"—exaggerated development of the premature systole in the bigeminal pulse.

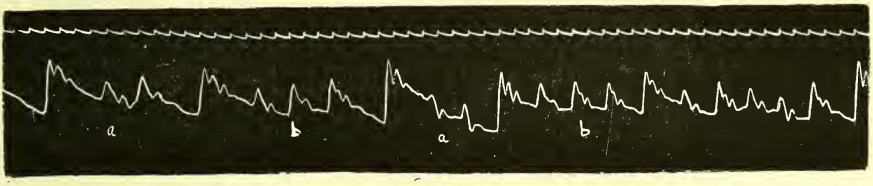

FIG. 74.—The "trigeminal pulse," *a*, *a*; the "quadrigeminal pulse," *b*, *b*.

These premature systoles may occur singly at rare intervals, or there may be a series of them following the regular ventricular contraction.

When the systole and the premature systole are of nearly the same size, and there is a long diastolic period between each pair of them, the pulse is sometimes called an alternating one—*pulsus alternans* (Fig. 73); it is simply an exaggerated degree of the bigeminal pulse. When the full systole is followed by two premature systoles we get the so-called *trigeminal pulse* (Fig. 74), and if three abortive contractions follow the full ventricular beat it is a *quadrigeminal pulse* (Fig. 74). After the first full systolic contraction a whole series of premature beats may occur (Fig. 75), and sometimes the entire sphygmogram may be composed of such immature systoles when the pulse is a rapid one.

The bigeminal, trigeminal, and quadrigeminal pulses are usually readily recognised, but sometimes when there is a *regular* irregularity, which occurs after every second, third, or fourth beat, the appearances produced are very similar (see Figs. 76, 77, and 78). The long pause, at first sight, seems to be due to a simple prolongation of the diastolic portions of the curve, but a second ventricular beat really occurs during the interval. By referring to the tracings shown in Fig. 79, which were taken from the same patient a few minutes after obtaining Fig. 77, *another* heart-beat is seen to occur during the pause. These sphygmograms tend to support the contention that a *true* ventricular intermission is exceedingly rare, and that in most instances the ventricle really makes a second and premature attempt to contract.

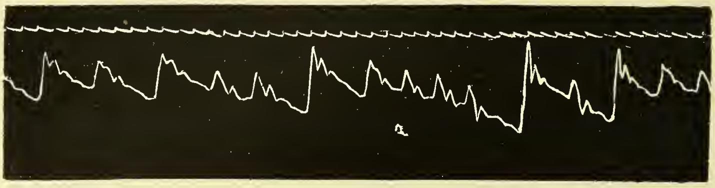

Fig. 75.—Series of premature systoles (*a*).

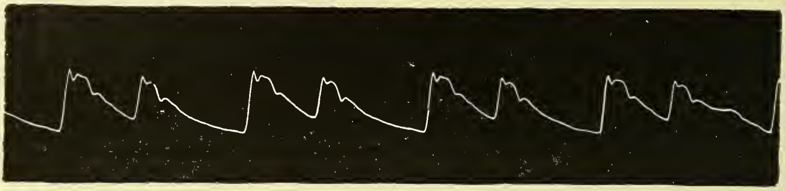

Fig. 76.—Regular irregularity after every *second* beat (the second beat may be a very exaggerated premature systole, and then the pulse would be of the ordinary bigeminal type; it is more probable that an early systole occurs during the long pause).

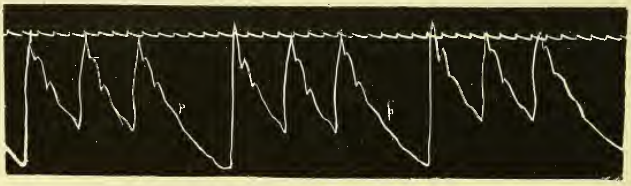

Fig. 77.—Regular irregularity after every *third* pulse-beat; *p* marks the occurrence of a premature systole.

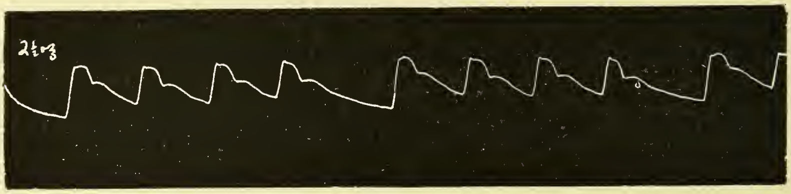

Fig. 78.—Regular irregularity after every *fourth* pulse-beat.

The Strong Pulse-beat after the Irregularity.—After the premature systole there is a long diastolic period, and during this time the arterial pressure falls to a very low point. The left ventricle becomes rather overfilled, and therefore there is almost always a specially strong beat after the irregularity (Fig. 80).

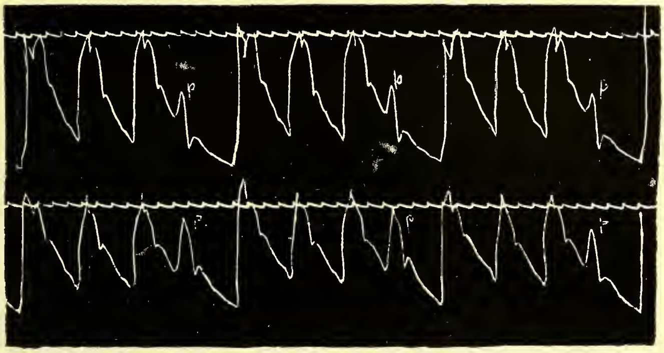

Fig. 79.—Gradual development of the premature systole (*p*) in the case of *regular* irregularity after every third beat. See Fig. 77.

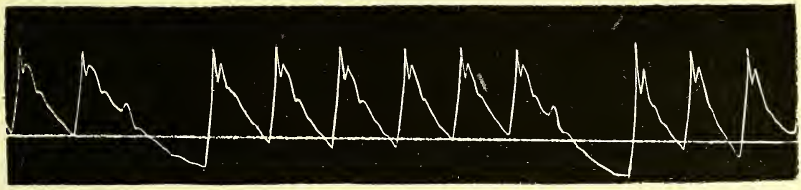

Fig. 80.—The strong pulse-beat after the irregularity.

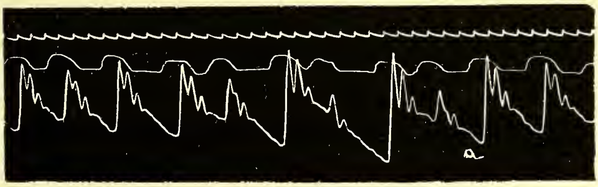

Fig. 81.—The *shortened* diastolic period after the premature beat of the heart (*a*); that shown in the preceding beat is the usual type. The upper tracing is from the apex beat.

In the adult type of pulse irregularity, then, the ventricle—owing, perhaps, to excessive irritability of its muscle—contracts a second time *before* its normal diastolic period is completed. The part of the diastolic phase at which the second contraction occurs is variable, and according to its position so will its character vary.

The Shortened Diastolic Period following the Premature Beat of the Heart.—Sometimes, though very rarely, the premature beat occurs so late that the diastolic period following it is *shorter* than that of the full contraction preceding it (Fig. 81).

The Cause of the Bigeminal Pulse.—It is very difficult to say why the ventricle in these cases contracts prematurely. It is not improbable that in some cases a toxic condition of the blood acts as an exciting cause. In elderly patients of gouty habit this type of pulse irregularity is very common, and would sometimes seem to be accentuated during the height of an attack. The intrinsic ganglia of the heart may also become unduly excitable, but it is unlikely that the vagus plays any part in the production of this type of irregularity. Stimulation of the vagus slows the heart, whereas the pulse is often rapid when premature systoles occur.

Pulse Irregularities due directly to Respiration.—Before leaving this subject mention may be made of another type of pulse irregularity which is apparently due to respiratory causes. Attention may at present be directed to those irregularities which occur with normal or slightly exaggerated breathing. Those forms which are dependent upon laboured or otherwise abnormal respiratory movements will be discussed in a subsequent section.

The first type of irregularity of this kind is that in which the *inspiratory* movement is specially concerned. When the tracing is examined, it is noticed that some of the pulse-waves in the series are of smaller size than others. The appearance is not quite the same as that of the ordinary form of youthful irregularity already described. I append a tracing from a baby five months old, where this character can be easily recognised (Fig. 82). When a simultaneous respiratory record is made it is found that the shorter waves correspond to the height of the inspiratory phase. Other tracings show the same features, and this irregularity is sometimes present under chloroform anæsthesia, when the respirations are deep.

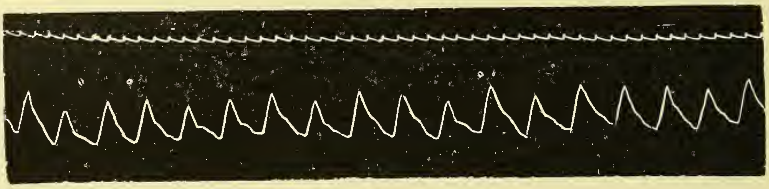

Fig. 82.—A type of irregularity due to respiration in an infant æt. 3 weeks—the smaller pulse-curves correspond to inspiration (normal breathing).

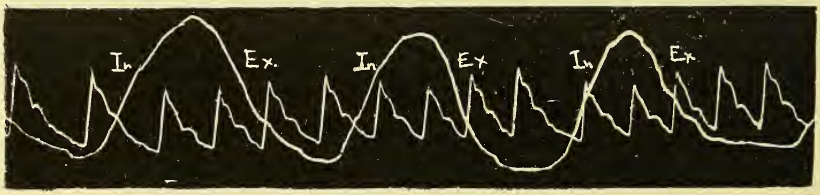

Fig. 83.—Respiratory irregularity where more than a single pulse-wave is affected (really a pulsus paradoxus). See page 233.

It is obviously sometimes difficult, if not impossible, to decide in what manner respiration brings about these alterations in pulse form and rhythm. But we may take it for granted that they are not always induced in the same way, and in many cases the action of the vagus in their production is not excited by respiratory influence on the medulla.

More than one pulse-wave in the series may be affected in the manner described by each inspiratory movement, and sometimes the curves occurring during expiration are unusually large. A tracing from a girl, twelve years of age, suffering from chronic rheumatic arthritis, shows these characters, and this form of respiratory modification of the pulse often occurs in children (Fig. 83). The irregularity shown in this tracing evidently bears a close relationship to the respiratory curve; its characters are not quite the same as those of the ordinary type of youthful irregularity.

Pulse and Respiration

Importance of making Graphic Records of both Events.—Pulse and respiration is a comparatively unworked field of research. In the study of this subject under various conditions it is absolutely necessary to make simultaneous records of both events. This can now be accomplished most satisfactorily by means of Mackenzie's "clinical polygraph." This small apparatus is attached to the ordinary Dudgeon's sphygmograph, and it records the respiratory curve on the same strip of smoked paper as that which registers the radial pulse.

The Clinical Polygraph.—The following short description of the instrument is taken from Dr. Mackenzie's paper on the "Venous Pulse." It consists of a tambour (A in the figure) supporting the writing lever, the latter being 6 inches in length. From the under-surface of the tambour a pipe protrudes, which is connected by india-rubber tubing with a receiver. The receiver is simply a small shallow vessel, made of lead or some other metal, and is used to receive the impressions from the pulsating artery or vein or from the apex-beat. Screwed tightly to the bottom of the tambour is a stem (B), 6½ inches in length, projecting outward, parallel to the under surface of the tambour. Half an inch of the other extremity of the stem is bent almost at right angles (C), and this portion fits into a slot in the upright stem that supports the movable lever of a Dudgeon's sphygmograph, and this supports the tambour. When the tambour arrangement is adjusted to the sphygmograph the tambour rests with its movable surface vertically, so that the writing lever moves horizontally. The point of the writing lever can be adjusted to any desired place on the recording paper, as there are several movements available at D, E, and F. By this method any pulsatile movement or the respiration can be recorded at the same time, and on the same paper as the radial sphygmogram. Ordinates are made by allowing the levers to write on the paper before starting and after stopping. With a pair of compasses the relative time of the events can be accurately gauged.

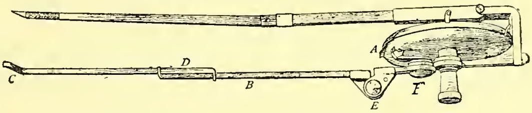

Fig. 84.—Mackenzie's "Clinical Polygraph."

Use of the Clinical Polygraph in Children.—The writer has been able to use this little instrument without difficulty, even in new-born infants, either to record the movements of respiration or of the left apex-beat along with the radial pulse. The tracings are admirable, and we now possess a ready and accurate means of studying the influence of the respiratory movements on the circulation. Graphic records of the different types of respiratory movement as found in various states of dyspnœa are of much interest, and these are as yet imperfectly recognised. Clinically, we know that such types exist under conditions of laboured breathing, but the precise relations of the inspiratory to the expiratory phase are not always adequately appreciated. With regard also to the time of occurrence of the *respiratory pause* under various circumstances, much has still to be learnt.

Effects of certain forced Respiratory Movements on the Pulse.—In the dyspnœa of advanced cardiac failure, with the circulation nearly at a standstill, the pulse seldom shows any respiratory variation. Hiccough apparently affects most pulses by causing a temporary arrest of the circulation and a fall of blood pressure, and very deep inspiratory and expiratory efforts with closed mouth and nose—the so-called Muller and Valsalva experiments—have also a marked influence. The soft pulse of low pressure is undoubtedly more susceptible to these altered respiratory movements. Pulses of high pressure are not affected to nearly the same degree.

It is certain that the physiological dictum that "during inspiration venous pressure falls and arterial pressure rises, and during expiration venous pressure rises and arterial pressure falls," is absolutely inadequate to explain all the variations of different pulses produced by altered respiratory movements in various conditions. The whole question is one of extreme complexity, and many different influences are associated together to evolve certain results.

Probably the *quantity* and the *quality* of the blood circulating in the vessels of the medulla is the proximate determining cause of the chief variations, through the effects thus produced on the vital centres resident there.

Effects produced by Variations in the Quantity of Blood reaching the Medulla.—During inspiration blood is drawn away from the brain, as is easily demonstrable by watching the sucking in of an infant's fontanelle or the emptying of a full jugular vein. This means a lowering of the blood pressure in the bulbar vessels, and consequently a definite effect is temporarily produced on the control of the circulation exerted by the vagus and vaso-motor nerves.

In the case of the *vagus* centre, diminished blood-supply means *diminished stimulation*, and will lead to an inhibition of its influence in maintaining a normal pulse-rate. Thus in healthy individuals we would expect strong inspiratory movements to cause, in the first instance, a quickening of the pulse. This effect is often produced, but not invariably.

In the case of the *vaso-motor* centre, when its usual blood-supply is diminished, *stimulation occurs*, with the result that its activity soon comes into play in the shape of vaso-constriction and consequent rise of blood pressure.

Effects produced by Variations in the Quality of the Blood reaching the Medulla.—In the case of the *vagus* centre, blood deficient in oxygen or otherwise impure will result in *stimulation*, and the pulse will tend to become slow.

In the case of the *vaso-motor* centre, *stimulation* also occurs, with resulting constriction of the smaller arteries throughout the body and a rise of blood pressure. Thus it will be seen that the combined influence of *diminished quantity* and *impaired quality* of the blood in the medulla will produce, in the case of the *vagus* centre *opposite* effects, and in the case of the *vaso-motor* centre the *same* effects.

An appreciation of these facts may help to assist one in the interpretation of many sphygmograms obtained in cases of spasmodic asthma, and also in other diseases associated with laboured respiration and alterations in the quality of the blood.

The Effects of Afferent Impulses reaching the Vaso-motor Centre—The Depressor Nerve.—Still other influences have to be remembered in dealing with the whole problem of pulse and respiration in pathological conditions. The afferent impulses reaching the vaso-motor centre are of considerable importance, and under certain circumstances give rise to unexpected results. Impulses coming to the centre through most afferent nerves are followed by a reflex rise of blood pressure when the pulse is of low or of medium pressure. But if the vaso-motor centre is actively maintaining a high pressure in the arteries by constriction of their coats, thus inducing abnormally great distension of the heart and embarrassment of its action, then a special afferent impulse to the vaso-motor centre from the heart itself will act in an opposite way, and produce a fall in the blood pressure and relief to the heart.

This is a safety-valve mechanism, and the afferent impulse which brings it into play is conducted through the *depressor* nerve which depresses the centre, thereby producing dilatation of the intestinal vessels by means of the splanchnic nerves.

Action of the Depressor Mechanism in Normal and in Pathological Conditions.—This mechanism for regulating the blood pressure may be frequently called into action in normal individuals, but it is not certain that it always acts so precisely in diseased conditions. During a severe asthmatic seizure, where there may be marked vaso-constriction, and the heart is struggling against undue resistance, relief may be sometimes partially brought about in this manner, and the relaxation of the vessels leads to the lowering of the arterial pressure. When a long inspiration is taken and the breath held, the type of sphygmogram obtained is sometimes suggestive of the same thing—the curves may become larger and more dicrotic during the sustained inspiratory act.

The Connection between the Vagus and Respiratory Irregularities of the Pulse.—A great many of the varieties of respiratory irregularity of the pulse may be explained on the theory already advanced to account for the ordinary type of youthful irregularity. Special emphasis was laid on the fact, that when the pulse temporarily quickened owing to lessened vagus influence, the reaction back to the normal rate was apt to be too extreme. That is to say, the vagus, in regaining its influence, tends to slow down the ventricular beat too much at first, and it does not immediately strike the proper balance with the accelerators. In the ordinary pulse irregularity of the child it is not always the inspiratory act which leads to a temporary diminution of the vagus influence, and, therefore, a faster pulse. Many other causes operate on the rate of the heart, and some of these may act continuously for a time, during which the vagus control is overbalanced. This is what happens during *febrile* conditions, and when the temperature falls to normal the vagus reasserts its control, and the characteristic retardation in some of the beats is observed. When a child is kept resting in bed the vagus soon begins to acquire an increased power over the heart, and the irregular rhythm of the pulse is again evident. Ordinary inspiration does not exert a sufficient impression on the vagus centre to affect most pulses. Deep inspiratory movements, however, lead to a certain loss of vagus control and to a quickening of the pulse-rate. This is generally followed by an undue slowing of the next few beats, more or less marked, due to temporary over-action on the part of the vagus when its roots are again stimulated by increased blood-supply (Fig. 85).

Anything, therefore, which leads to a temporary or prolonged overbalancing of the vagus control on the heart, will, after its influence is removed, induce a form of pulse irregularity characterised by a lengthening of the diastolic portions of some of the pulse-curves. A deep inspiration is only *one* of the many causes which acts in this manner on the vagus centre, and the reaction of this influence is often seen in a prolongation of the diastolic portions of the curves during expiration, for at this period the vagus again regains its control. The tracing, Fig. 86, shows this form of pulse irregularity where respiration is purposely deep, but not abnormally rapid. However, in some cases of laboured and rapid breathing the pulse variations are of a similar character.

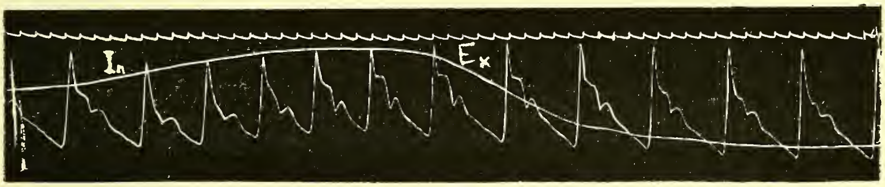

Fig. 85.—Quickening of the pulse with deep inspiration (loss of vagus influence over heart), with slowing at expiration (vagus regaining its influence). The quicker beats are more dicrotic.

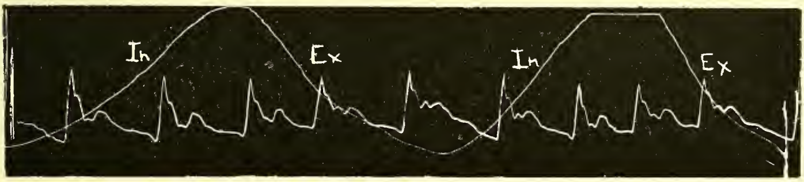

Fig. 86.—Effects of deep respiration in causing pulse irregularity; prolonged beats occur during the expiratory phase after the transient quickening at inspiration. The pulse-curves are more dicrotic during inspiration.

The Effects of Deep Inspiration on the Pulse.—It has been already stated that it is the soft, low-pressure pulse which shows the greatest variations with respiration. The effects of forced inspiration on a pulse of this character is to quicken the beats and render the curves more dicrotic. During the time of inspiration, and especially when the breath is held, the pulse-curves often become smaller and are of shorter duration. During expiration the curves become larger, and are generally more prolonged (see Fig. 86).

The Effects of Deep Expiration on the Pulse.—Holding the breath at the end of expiration does not seem to produce nearly so marked an effect on the pulse. It generally becomes somewhat slower, and may show a higher pressure. At the end of deep expiration, however, there is often a prolongation of the diastolic periods of the curves.

The Pulse with Slow Respiration.—When the breathing is slow and laboured—as in all cases of cerebral compression, tubercular meningitis, tumour, etc.—it is common to have one or more pulse-curves corresponding to the height of inspiration, markedly diminished in size and shortened in duration. The curves occurring at the end of expiration may be somewhat prolonged (Figs. 87 and 88). When the pulse is of high pressure, however, it may show very little respiratory variation (Fig. 89). The *type of respiratory curve* in some forms of cerebral compression is peculiar, and in several cases of simple basal meningitis the writer obtained tracings like that shown in Fig. 90. The respiratory *pause* occurs after inspiration. This occurred also in one case of broncho-pneumonia complicated by pleurisy with effusion, and it probably does not bear any special significance. In a case of measles ushered in by violent convulsions, with a pulse of great rapidity and a temperature of over 105°, this same peculiar type of breathing was found. But this form of respiratory curve does not seem to be present in cases of tubercular meningitis in young children.

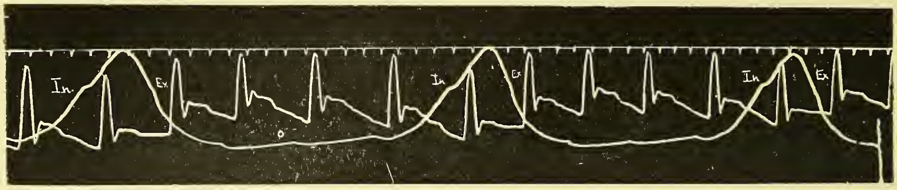

Fig. 87.—The pulse with slow respiration ; longer diastolic periods during expiration. At the time of inspiration there is a fall in the tracing. (Large cerebral hæmorrhage, boy æt. 12 years.)

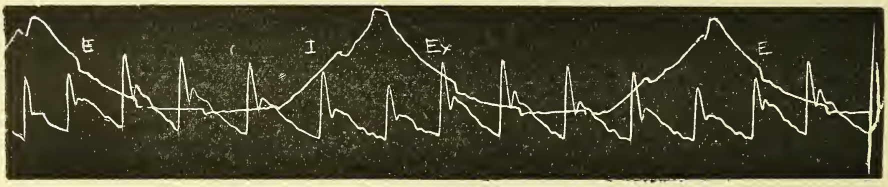

Fig. 88.—Pulse with slow respiration, showing the shorter and smaller curves during inspiration.

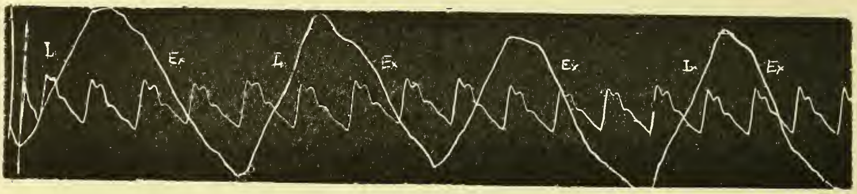

Fig. 89.—Very slight respiratory variations in the pulse when the arterial pressure is high. (Tubercular meningitis, child æt. 4 years.)

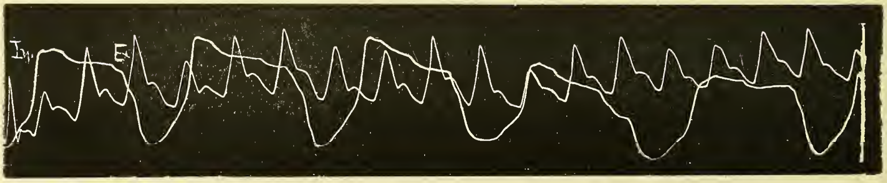

Fig. 90.—The type of respiration in simple basal meningitis ; respiratory pause occurs after inspiration. (Child æt. 16 months. Pulse 144, resp. 60, temp. 100°.)

The Pulse with Laboured Breathing.—When the respiration is very rapid, as in pneumonia, the pulse-tracing may show a short and a long beat alternately—the former coinciding with inspiration, the latter with expiration (Fig. 91).

Pulsus Paradoxus.—Kussmaul first directed attention to this form of pulse. The most characteristic feature is a distinct depression of the pulse-wave occurring synchronously with inspiration. This peculiar pulse was at one time supposed only to occur in cases where some pleuro-pericardiac adhesion existed. Something of the same kind has, however, been found in other conditions, such as simple pericarditis with effusion, pleurisy with effusion, in mediastinal tumours, and in aneurysm of the thoracic aorta.

Brockbank has called attention to its occurrence in children suffering from dyspnœa due to acute laryngitis.

The writer's own experience is, that in young children this *diminution* of the height of the *pulse-wave* during *inspiration* is the *rule* even when respiration is not much exaggerated. Forced inspiration is not always necessary to develop this feature in a child's pulse. With ordinary breathing it can frequently be detected in the sphygmogram.

One of the best examples of this form of pulse was obtained from a youth who was suffering from a mild asthmatic seizure. There was only slight wheezing present, and the breathing was not really difficult. On feeling the pulse it was found that it periodically varied in volume—so much so, indeed, that by gentle pressure on the artery the impulse seemed at times to be completely absent. Tracings were taken, and the relation of the pulse variation to the respiration was observed. Fig. 92 shows the characters of this pulse, and it is apparently identical in appearance with the so-called "pulsus paradoxus." There was no reason to suspect adhesive mediastinitis here. So this kind of tracing must simply be regarded as an exaggerated degree of the not uncommon diminution of the pulse-wave during inspiration.

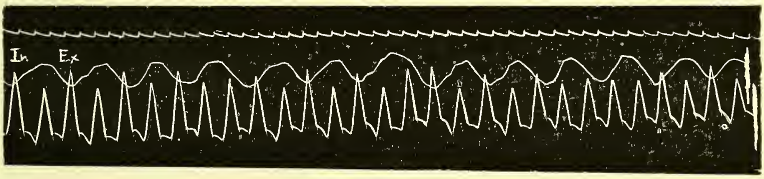

Fig. 91.—Pulse and respiration in pneumonia (fatal type), showing alternate large and small pulse-waves at expiration and inspiration.

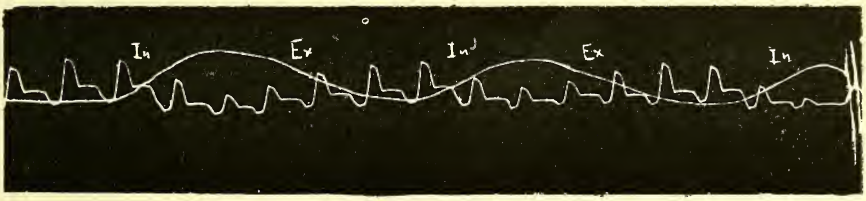

Fig. 92.—Inspiratory diminution of the pulse-curves in a slight case of spasmodic asthma. (Identical in appearance with the true pulsus paradoxus of mediastino-pericarditis.)

Causes of the so-called Pulsus Paradoxus.—In a paper on the "Effects of Forced Inspiration on the Pulse in some Forms of Heart Disease," Irvine discusses this question pretty fully. He agrees that the occurrence of the pulsus paradoxus may often be associated with pleuro-pericardiac adhesion, but he goes a step farther, and states that a weakening of the heart muscle, due to myocarditis or by effusion into the pericardium, has a share in bringing about this pulse depression.

It is quite certain, however, that the causes already mentioned do not often come into play in the occurrence of this inspiratory variation of the pulse in children.

Brockbank recognises the need of some other explanation to account for the pulsus paradoxus of acute laryngitis in children. In such cases he thinks it is to be found in the great variations of the intrathoracic pressure on the heart and great vessels in the chest cavity. Without going fully into the matter, it may be stated that *difficulty in getting the air into the lungs* is the key-note of his theory—the in-rushing air cannot enter fast enough to fill the expanding lungs. This means that the left ventricle has to pump its contents out of a vacuum into positive pressure.

Explanation of the common Occurrence of this Pulse Peculiarity in Children.—Brockbank's view may explain why this pulse peculiarity is of such frequent occurrence in young children, even in normal conditions, because the larynx and trachea are of relatively small size. He apparently does not recognise how common this inspiratory pulse diminution is, for he regards its occurrence in acute laryngitis as specially noteworthy.

Extensive employment of the sphygmograph in children leads the writer to the conclusion that this pulse variation is almost invariably met with in all conditions of laboured breathing, whether fast or slow.

Anything which causes obstruction to the entrance of air into the lungs during inspiration accentuates this pulse depression (Fig. 93). Its occurrence has been noted in children who were largely "mouth breathers," owing to enlargement of the tonsils, or in those who were affected with adenoids. Personal experience would therefore lead me to support such a theory as Brockbank advances.

There are, however, certain special features and characteristics of the *pulsus paradoxus*, as seen in cases of mediastino-pericarditis, which distinguish it from the simple diminution of the pulse-wave which occurs so frequently in children with ordinary or slightly exaggerated inspiration under various other conditions.

The writer believes it would be advisable to restrict the use of the term pulsus paradoxus *exclusively* to that type of pulse which occurs in well-marked cases of mediastino-pericarditis; the term should not be applied to any other form of inspiratory diminution of the pulse-curve, however marked it may be. Harris, in his admirable monograph on "Indurative Mediastino-Pericarditis," quotes from Schreiber, who regards the following peculiarities as distinctive of the true pulsus paradoxus:—

(1) Marked diminution in the volume or complete disappearance of the pulse of all arteries, and not only of that of the radial vessels, during inspiration, and especially in the second half or at the end of that act.

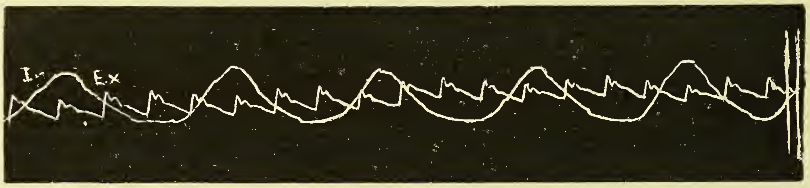

Fig. 93.—Slight degree of inspiratory pulse diminution in a child affected with adenoids.

(2) The impossibility of replacing the paradoxical pulse by a full pulse by a prolonged and sustained inspiration.

(3) The pulsus paradoxus does not require for its development the inspiration to be deep.

(4) The pulse intermission is accompanied by a regular action of the heart, and the heart shows

(5) No weakening of its action during the period whilst an inspiration is being made (four and five might, however, be modified in cases where there is, at the same time, endocarditis or myocarditis).

In addition to the above-mentioned characters Schreiber mentions an associated symptom of great importance—*inspiratory* swelling of the cervical veins.

Diminished Radial Calibre during Inspiration.—In some cases the kind of tracing obtained suggests that the calibre of the radial artery actually becomes smaller during deep inspiration. The pulse-curves during this period seem to indicate that the artery is contracted, and that its elasticity is impaired. The instrumental apex of the systolic waves is not developed in the smaller curves which occur during inspiration, and this might be taken as evidence that the artery is more fully under vaso-motor influence at this time. The effect of inspiration on the vaso-motor centre in the medulla is to cause stimulation, and it is conceivable that sometimes the arteries are alternately contracted and relaxed as a result of deep inspiratory and expiratory movements.

The Influence of the Blood Pressure in the Venæ Comites Radiales in the Production of Respiratory Variations in the Pulse.—Leonard Hill and others believe that the veins which surround the radial artery bear an important share in the production of many of these respiratory variations of the pulse. There is, these observers state, a mechanical displacement of the button of the sphygmograph above the level of the artery, due to a distension of these veins. In pathological conditions where, by back pressure, the tension in the venous system is greatly raised, this filling of the venæ comites is supposed to account for the various modifications of the sphygmographic tracing which have already been described.

The following passage is quoted from Hill's article on the Circulation in Schäfer's *Text-Book of Physiology*. He says: "The sphygmogram shows variations synchronous with the respiratory movements. Normally these are slight, but they become marked whenever the respiration is either deep or partially obstructed. During deep inspiration the line of the tracing falls, whilst the excursion of the primary wave decreases, and the dicrotic wave becomes more evident. The venæ comites radiales are here emptied, and the expanded lungs swallow up the blood, so that the arterial tension falls slightly. When expiration follows, the line of the tracing rises, and the excursion of each pulse is increased. During a deep inspiration the vessels in the radial sulcus appear to the finger of less breadth and of lower tension. In obstructed breathing the pulse-beats may, during inspiration, almost disappear, for the air cannot then enter freely, and thus the force of the inspiratory movement is thrown largely on to the intrathoracic vessels and the heart."

Results of Clinical Observations on the Pulse during Laboured Breathing.—An examination of the writer's pulse- and respiration-tracings from children and adults shows that the line of the tracing does *not* fall during deep inspiration, except in a very small proportion of cases. In these instances the accessory muscles of respiration were generally called into action, and they probably caused slight movements of the arm which affected the tracings during inspiration (Figs. 94 and 87). By supporting the arm firmly so as to minimise such movements, this kind of so-called respiratory variation disappears.

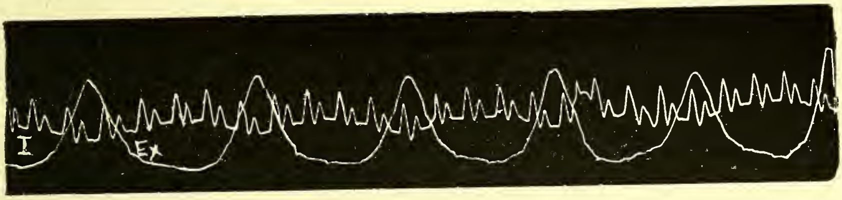

Fig. 94.—The *fall* in the level of the tracing during inspiration is due to mechanical movements of the arm from the participation of the accessory muscles of respiration in the act.

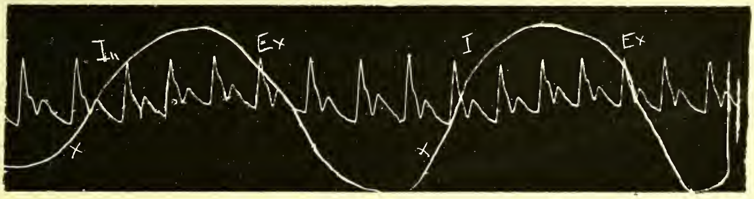

Fig. 95.—To show the *raising* of the level of the pulse-curves during inspiration.

These observations seem to show that inspiration very often simply leads to a *diminution* of the pulse-curve without lowering the level of the tracing. On the contrary it sometimes happens that there is a *raising* of the level of the pulse-curves during the inspiratory phase (Fig. 95), while the succeeding curves show prolonged diastolic portions coincident with expiration. The diastole of the inspiratory pulse-wave may then be incomplete.

It is very improbable that venous stasis and engorgement really modifies the sphygmogram so generally, or in such a marked manner as Hill asserts. Clinically, in carefully made observations, we need only seriously consider this interference in a very small number of cases.

Hill's Estimate of the Power attained by Venous Pressure.—Hill ascribes enormous power to venous pressure. During the performance of Valsalva's experiment—forced expiration with the mouth and nose shut—he says the pressure in the venæ comites radiales rises to the mean arterial pressure. We do not think this opinion is shared by many physiologists.

Dr. Oliver has failed to detect a direct relation between the evidence of a high radial calibre and that of venous pressure above the average; he has, on the contrary, repeatedly met with low readings of the radial calibre when venous pressure was exceptionally high. An analysis of Hill's tracings (Schäfer's *Text-Book of Physiology*, vol. ii. p. 105) would seem to indicate that the distended venæ comites are capable of lifting the pad of the sphygmograph through a greater distance, and therefore with a force greater than that exerted by the systole of the left ventricle. It is surely seldom, if ever, that venous pressure can attain this power.

Results of Pulse- and Respiration-Observations on Animals.—The writer has, with the able assistance of Dr. Noël Paton, made some pulse- and respiration-observations on animals, in order to control certain results obtained during laboured breathing in children. The cat was the animal employed. Under ether anæsthesia one of the carotid arteries was fully exposed, and a portion of the artery, separated from the vein, was supported by a piece of wood which was held by a clip attached to a heavily-weighted stand. The artery thus lay upon a perfectly rigid bed. A Dudgeon's sphygmograph, with a clinical polygraph attached to record the respiratory curve, was held firmly in a suitable apparatus in such a way that it could be made to rest accurately upon the artery. The trachea was opened and a cannula inserted, through which the animal breathed.

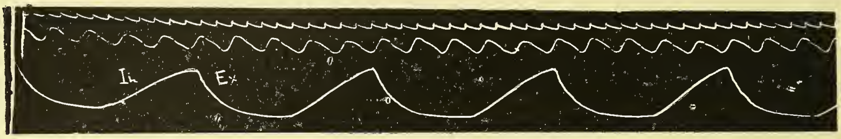

Fig. 96.—Pulse and respiration of a cat under deep ether anæsthesia.

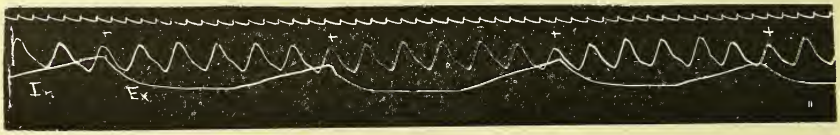

Fig. 97.—Pulse and respiration (cat). Shows the diminution of the pulse-waves at the height of inspiration (fairly deep respiration).

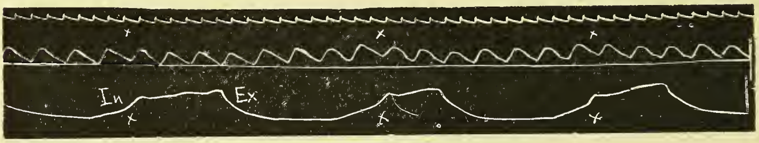

Fig. 98.—Pulse and respiration (cat). The line of the tracing is *raised* during inspiration (respiration is deep).

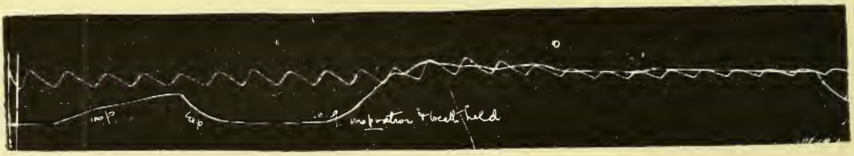

Fig. 99.—Pulse and respiration (cat). The effect of a long inspiration with breath held is to raise the level of the tracing and diminish the amplitude of the pulse-curves.

The object of these experiments was to ascertain whether the diminution of the pulse-wave, occurring so commonly in children during slightly exaggerated or obstructed breathing, could be obtained when the pad of the sphygmograph rested upon *the artery alone.*

The first tracing, Fig. 96, shows the pulse-curves along with normal respiration under deep anæthesia. The animal was breathing fairly deeply, and each pulse-wave at the height of inspiration is, even here, slightly diminished in amplitude.

The next tracing, Fig. 97, shows the effects of a series of fairly deep breaths.

Now, there is a distinct diminution of each pulse-curve at the height of inspiration. The pen which records the respiratory curve starts a short distance behind that which registers the pulse, so this must be allowed for in the timing of the two events.

Fig. 98 shows the effect of taking three fairly deep respirations. The line of the tracing is slightly *raised* during inspiration.

Fig. 99 shows the effect of taking a long inspiration and then holding the breath. Again a slight *raising of the line of the tracing* occurs, but it is shortly followed by the usual result, namely, the diminished size of the curves. A sufficiently deep breath will practically abolish the pulse-wave, and thus produce an extreme degree of the so-called pulsus paradoxus.

Another tracing is appended, Fig. 100, which shows the raising of the level of the pulse-tracing produced by inspiration when the animal was dying. The india-rubber bag which transmitted the respiratory movements to the tambour of the clinical polygraph was fixed to the thorax of the animal in such a way that it lay over the cardiac area, and therefore received the pulsations of the ventricle. The animal was at this time only making an occasional sighing respiration. Therefore the record of heart-beats in the tracing is only broken twice by a respiration. Each time, however, when this occurs there is a distinct elevation of the line of the tracing.

The Effects of Venous Pressure on the Form of Pulse Tracing are, clinically, unimportant.—It seems clear from these experiments that this common respiratory variation of the pulse—diminution in the size of the beat—is not necessarily due to alterations in the pressure of the veins upon which the pad of the sphygmograph may rest at the time the tracing is made.

The writer believes that the force of the inspiratory movement acting on the intrathoracic vessels, and also directly upon the heart itself, plays the chief part in the production of many of these variations of the pulse-wave. In some instances, perhaps, inspiration may induce certain changes in the pulse through effects produced on the vaso-motor centre. Brockbank's explanation of the pulsus paradoxus in acute laryngitis is based upon the effects produced by the expanding lungs on the heart and vessels within the chest, and the form of pulse obtained in this condition is simply an exaggeration of the common inspiratory variation of children. Hill recognises this influence of inspiration on the intrathoracic vessels, but asserts that it affects the sphygmogram mainly through alterations thus produced in the pressure of blood in the veins accompanying the radial artery. It is most unlikely, however, when the left ventricular systole raises the pad of the sphygmograph through a certain space, that the venous pressure in the venæ comites is capable of raising the pad through a greater space, and, clinically, the careful observer may practically ignore the participation of the veins in the modification of the sphygmogram.

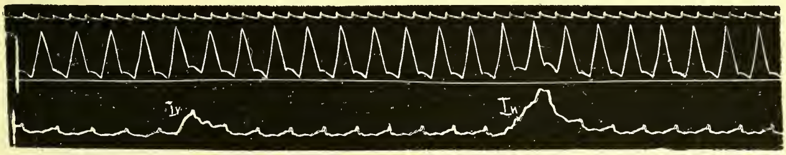

Fig. 100.—Pulse and respiration (cat). The animal is dying, and the lower tracing records the heart-beats, which are twice broken by a sighing respiration (In). The raising of the level of the tracing at inspiration is again observed.

HEART MOVEMENTS

The Apex-Beat.—The left apex-beat indicates the chief movement of the heart. It may often be found in the fourth interspace, and outside the nipple line in children, but in adults it is normally well inside this line. When this movement is produced by the left ventricle it is due to a displacement *forwards* of the hardened apex of the heart. During the whole period of systole the apex of the heart is lying against the interspace in the chest wall.

The Component Parts of the Cardiographic Tracing.—The ordinary cardiogram from the left ventricular systole may be interpreted as follows (see Figs. 101 and 102):—1. The forward movement of the ventricle as it *begins to contract* (D). 2. Retention of the apex against the interspace, *i.e. full contraction* (E). 3. The backward movement of the ventricle as it *begins to dilate* (F). 4. The gradual swelling of the ventricle up to the *full dilatation* (G). Sometimes a small elevation (*a*) before the period D marks the contraction of the auricles.

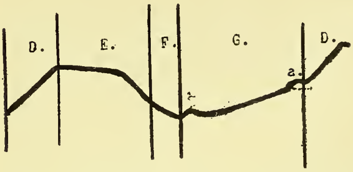

FIG. 101.—Diagrammatic representation of the ordinary cardiogram. Filling of the ventricles from the auricles. *a*, Contraction of auricles.

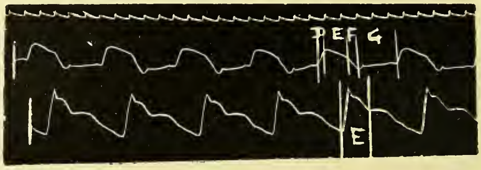

FIG. 102.—The ordinary cardiogram from the apex beat of a child æt. 10 years, showing the different phases of the ventricular contraction. The lower tracing was taken simultaneously from the radial pulse. A *rise* in the cardiographic tracing occurs at the time of ventricular systole; E in sphygmogram.

The period E may be very transient if the ventricles shrink during their systole away from the interspace (Fig. 103), and it may be represented by a large, well-sustained elevation, the "systolic plateau," when the apical protrusion into the interspace is forcible and lasting (see Fig. 104).

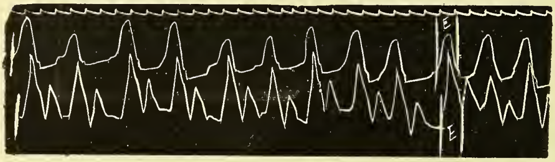

FIG. 103.—Cardiogram where the retention of the ventricular apex against the interspace has been transient—rounded instrumental apex, E, to the curve due to "shock" of systole.

The "Shock" due to the Systole of the Left Ventricle.—The *shock* due to the left ventricular systole is important, for it is quite a different thing from the systole itself. The systole lasts during all the time of the apex-beat. The "shock" may often be a transient portion of the cardiogram, but it may jerk up the lever of the instrument and form a large instrumental apex in some tracings, which is sometimes *the only* movement distinguishable.

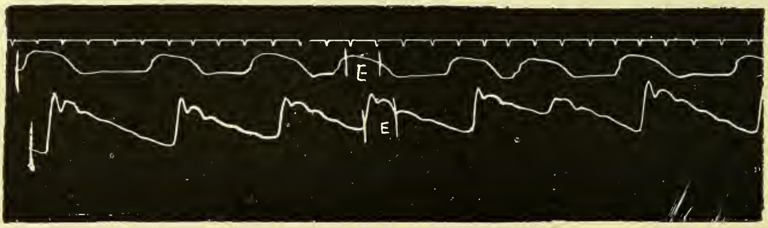

FIG. 104.—Cardiogram to show prolonged retention of heart's apex against the interspace; period E is the "systolic plateau."

The "shock" and the apical protrusion may sometimes appear as two distinct elevations, just in the same way as the "systolic wave" in the sphygmogram may appear as a divided summit.

Value of Simultaneous Cardiographic and Pulse Tracings.—The cardiographic tracing when made simultaneously with that of the radial pulse is of great assistance in the interpretation of the various forms of irregularity and intermittency. The impulse from the left ventricle may also often be used to time the occurrence of other movements which are sometimes found over the cardiac area, or such movements may be timed with the radial pulse, which is practically the same thing.

Retraction of Tissues near the Heart during the Ventricular Systole.—It is important to remember that when the heart contracts and pushes its apex into the fourth or fifth interspace, it at the same time *draws in* the tissues *round* the interspace. As the heart shrinks during its systole the yielding structures near it *retract*, and thus there is sometimes a *sucking in* of the skin over certain areas at the time of the pushing out of the skin by the left ventricular apex (apex-beat).

We may briefly consider a few of these movements, and their relationship to the cardiogram of the left apex-beat or to the radial pulse.

Epigastric Pulsation.—First with regard to *epigastric pulsation.*

In the acute dilatation of the heart of diphtheria, acute pneumonia, and rheumatism, as well as in advanced valvular disease, one frequently observes very marked pulsation in the epigastric region. This is an important symptom, because it shows that the right side of the heart has enlarged sufficiently to cause a movement of the skin over this area during the systole. Sometimes the skin in this region is *pushed out* during the systole in the same manner as it is in the fifth interspace by the apex-beat, but this is very unusual.

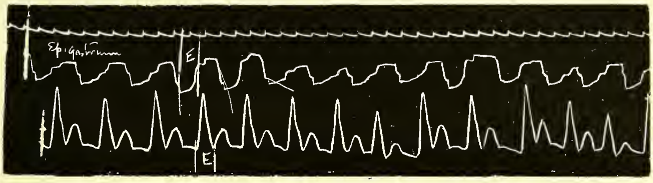

FIG. 105.—The "inverted cardiogram" from the epigastrium. A *depression* in the cardiographic tracing occurs at the time of the systole of the ventricle; E in radial pulse tracing. (Boy æt. 16 with greatly dilated heart.)

The *usual* movement, when any pulsation is found, is a distinct *retraction* of the skin in this situation at the time of the ventricular systole.

In the dilated heart it is necessary to fully appreciate the fact that the *right* ventricle practically occupies the whole of the cardiac dulness; only a small strip of the left ventricle lies superficially enough to be included in this area. Hence under these circumstances, as Mackenzie has pointed out, what is felt as the apex-beat may not be produced by the protrusion into the interspace of the hardened left ventricular apex. The dilated right ventricle is now occupying this situation, and at the time of its systole, instead of a "pushing out" of the interspace, there is a "sucking in." Thus a *fall* will be produced in the cardiographic tracing at this time instead of a rise when the "receiver" is recording the movement. Should the right ventricle be sufficiently dilated to extend into the epigastrium a similar movement will be obtained in that region at the time of its systole. Here the "sucking in" may possibly be accentuated, because the left ventricle, when it contracts and hardens, tends to pull the right ventricle inwards, that is, away from the epigastrium.

With regard to epigastric pulsation, then, a simultaneous record of the two events, heart and pulse, shows that the systolic portion of the pulse-curve corresponds to a *depression* in the cardiogram, which indicates that the epigastrium has been *drawn in* instead of pushed out at the time of the ventricular contraction (Fig. 105). Mackenzie has called this the "*inverted cardiogram*," and in adults he finds that it is almost invariably due to the systolic contraction of the *right ventricle.* Such a type of cardiogram, if obtained over the usual situation of the apex-beat, shows that the right ventricle is occupying that part of the cardiac dulness, and signifies extreme dilatation of the heart. In children, however, the writer has occasionally found that epigastric pulsation is due to a greatly enlarged left ventricle, and a tracing of a fairly typical cardiogram is obtained (Fig. 106). It is difficult to see how the left ventricle can occupy this situation unless the whole heart is twisted round on its long axis. Attention has already been drawn to the fact that under treatment, when the dilatation of the ventricle subsides, the epigastric impulse disappears.

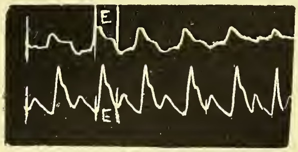

Fig. 106.—Epigastric pulsation from a child aged 9 years, with rheumatic fever and dilated heart; the cardiogram is *not* of the "inverted" type.

Pulsation from the Abdominal Aorta.—The abdominal aorta may sometimes communicate a pulsation to the epigastrium. It is then, of course, a systolic protrusion and not a retraction, and is easily distinguished from the ordinary, or from the inverted cardiogram. Its systolic portion is synchronous with that phase in the radial sphygmogram, and there is no phase corresponding to the period D of the cardiogram—the so-called "presphygmic" period.

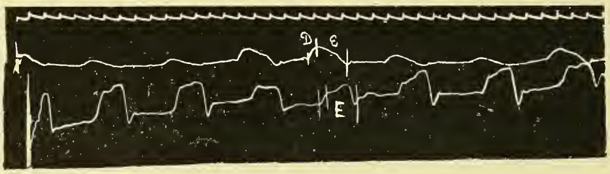

Fig. 107.—Simultaneous tracings from the left apex-beat (upper tracing) and from the pulmonary artery (lower tracing). The movements are synchronous.

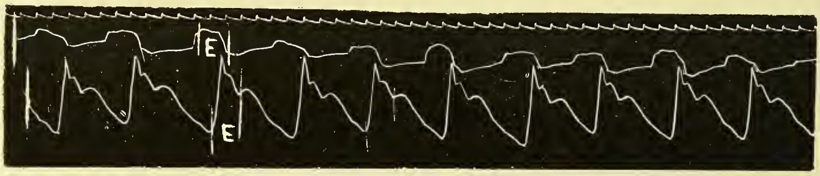

Fig. 108.—Simultaneous tracings from the pulmonary artery and radial pulse, showing the correspondence of the systolic portions, E.

Impulse from the Pulmonary Artery.—Among other pulsations seen over the cardiac area mention may be made of that due to the *pulmonary artery.*

Fig. 107 is a tracing taken from a girl ten years old who had a severe attack of rheumatic fever, and the pulsation recorded is evidently directly communicated by the pulmonary artery. There was visible pulsation over the region of the left auricle, and it was doubtful whether it was an auricular movement or one due to the pulmonary artery. Two tracings are given which clearly show that the impulse is not an auricular one, and that the movement is quite synchronous with the systole of the left ventricle and with the radial pulse (see Figs. 107 and 108).

Other Movements over the Præcordial Region.—Other movements over the præcordia are generally due to a retraction of the tissues coincident with the apex-beat. A tracing reveals their true significance when timed with the radial pulse.

Supposed Auricular Pulsation.—A case of special interest may be briefly referred to. A girl aged five years had a congenital cleft in her sternum, just over the site of the left auricle. There was marked pulsation here which was supposed to be auricular. The movement, however, lasted over a longer period than one would expect for an auricular contraction, and it was not altogether suggestive of the pulmonary artery. Tracings of the pulsation were taken simultaneously with the radial pulse. Fig. 109 shows the result. It is a good example of the " inverted cardiogram," and therefore the movement was really due to a sucking in of the tissues above the site of the apical protrusion, or it may possibly have been caused by the systole of the right ventricle.

One sometimes obtains quite a similar tracing, however, off the pulmonary area in children. Fig. 110 is an example; the systolic portion of the radial pulse corresponds to a *fall* in the cardiographic tracing; it is therefore an " inverted cardiogram."

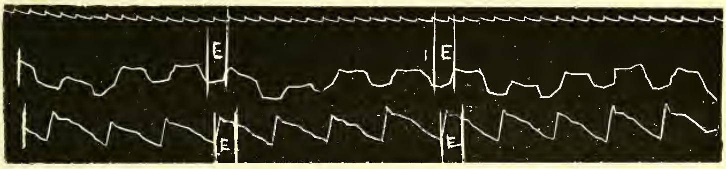

Fig. 109.—Supposed auricular pulsation—really an " inverted cardiogram." Systolic portion of radial sphygmogram E corresponds to a depression in the cardiogram.

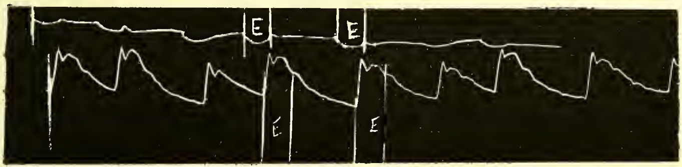

Fig. 110.—Tracing taken from the pulmonary area in a child aged 3 years. There is a retraction of the skin over this area (inverted cardiogram) at the time of ventricular systole, E (radial pulse).

Cardiograms obtained directly off the Left Ventricle.—The writer had a unique opportunity, through the kindness of Mr. Dowden, of obtaining cardiograms *directly* off the left ventricle from a child five years old.

A patient under his care suffered from multiple pyæmic abscesses, and one, which formed over the left mammary region, was observed to communicate a cardiac rhythm. It was incised, and pieces of rib were removed. An opening was thus left in the chest wall through which the ventricle, covered by the pericardium and the visceral layer of the pleura, could be easily seen. A small metal "receiver," with rubber tubing attached, was thoroughly sterilised, and was passed through the wound on to the surface of the left ventricle. The other end of the tubing was connected with the tambour of the clinical polygraph. This was then attached to a Dudgeon's sphygmograph, which was used to make a simultaneous tracing of the radial pulse. As a control observation a tracing was taken by putting the "receiver" on the skin over the site of the apex-beat, and an ordinary cardiogram was obtained. The deep respiratory movements led to some alteration in the characters of the tracing obtained directly off the ventricular surface, but it is quite similar to that made from the apex-beat (Fig. 111). The "receiver" was probably over the apical portion of the left ventricle, and the tracing represents the hardening of the muscle at its systolic contraction—an ordinary left ventricular cardiogram.

Direct Mechanical Stimulation of the Heart under Chloroform.—While the child was under chloroform the heart was touched with the point of the finger, and also with dressing forceps. Direct stimulation applied in this way had no effect whatever on the ventricular beat. The slightly smaller pulse-waves seen in the tracing correspond to inspiration.

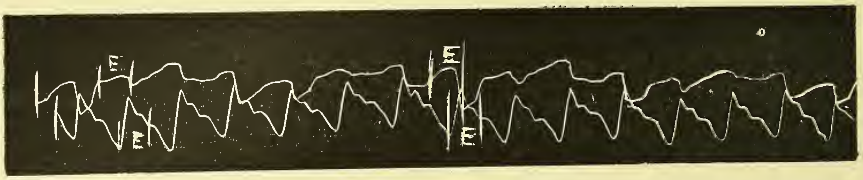

Fig. 111.—Simultaneous tracings *directly* off the left ventricle and from the radial pulse; the "systolic plateau" E corresponds in time to the systolic portion of the sphygmogram. The respiratory movements have modified the cardiographic tracing.

The Pulse in Tubercular Meningitis

There are certain diseases in which the characters of the pulse, when carefully studied by means of the sphygmograph, bear some diagnostic or prognostic significance. In the present article the special types associated with tubercular meningitis and pneumonia will be shortly considered.

The Pulse of Tubercular Meningitis in Young Children.—At a certain stage in the course of tubercular meningitis a slow, irregular pulse is often found, and it is regarded by some as a symptom of considerable value in diagnosis. In children under two years of age, however, a markedly slow irregular pulse is not often observed. The writer has gladly availed himself of Dr. John Thomson's experience in this disease. In a series of eighteen cases, examined by Dr. Thomson, occurring in children whose ages ranged from a half to two years, the pulse was, in three of these only, under 90 per minute, and irregular in rhythm. But irregularity was sometimes noted when the pulse was much more rapid.

Irregularity of the Respiration in Tubercular Meningitis.—During the early period of tubercular meningitis in children under two years of age very irregular breathing often coexists with a regular rapid pulse. As an early symptom in these cases, *marked irregularity of the respiration* may be a suggestive and important sign—it is more significant, and more to be relied on in diagnosis, than mere irregularity of the pulse.

In children over two years of age, however, one undoubtedly often meets with a rather characteristic pulse in the early stages of the disease. We say *rather* characteristic, because as a single symptom we do not think it can often be absolutely relied upon for purposes of diagnosis.

Irregularity of the Pulse in Tubercular Meningitis.—Most authorities speak of this pulse as an *intermittent one;* and if one could admit the correctness of some of the text-book descriptions, then the features possessed by it would indeed be sufficiently characteristic to distinguish it from almost any other. So far as the writer's observations go, he does not think the mere *irregularity* means much, because to the finger it is precisely similar to that of the usual type of youthful irregularity already described.

The *slowness* of the pulse, occurring at a time when the temperature is elevated, often to a considerable degree, is significant, but of still greater suggestiveness is the *contracted* state of the radial artery. This, in the writer's opinion, is a very striking condition, and it is an unusual one in young children. There is sometimes a very marked degree of contraction present, and the artery can be rolled like a piece of whip-cord under the finger. The pulse is always slow and hesitating when the vaso-constriction is very pronounced, for the ventricle is then acting against greatly increased peripheral resistance. In this disease slight elevation of the temperature does not always lead to relaxation of the arteries, so the pulse-rate does not quicken. Hence the suggestive triad of symptoms—pyrexia, slow irregular pulse, and contracted vessels.

General Use of the Term "Intermission" in describing this Form of Pulse.—In the description of this pulse irregularity hitherto, the term "intermission" has generally been used. It has already been pointed out, in the classification of pulse irregularities, that the term intermission should only be employed when it can be definitely proved that a whole heart-beat is entirely missed out. There is no absolute certainty that this *true* ventricular intermission occurs in man, except on very rare occasions; and the writer has never met with it in children, nor, so far as he knows, has any one else. By trusting to information derived from the use of the finger alone, the pulse in tubercular meningitis has been called "intermittent" in the sense that an entire heart-beat is, from time to time, omitted altogether. Thus Eustace Smith says, "a slow, irregular pulse, *especially if the intermission be complete*, very greatly increases the value of the symptoms with which it may be associated. It must, however, be remembered that during convalescence from acute disease the pulse in a child often becomes slower and irregular, and may even *completely intermit*, especially during sleep." In another place he states that "the irregularity in rhythm is particularly well marked, because, as a rule, *the intermission is complete.* This is the more evident on account of the slowness of the pulse. Several beats strike the finger in regular succession, and then suddenly *one beat is entirely omitted*, and there is a pause until the rhythm is again taken up by the succeeding beat."

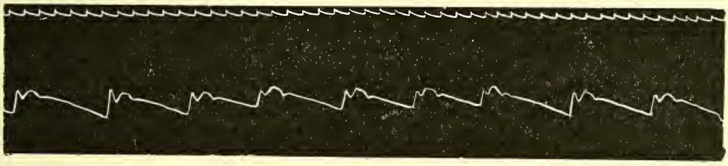

FIG. 112.—Pulse in tubercular meningitis (child æt. $3\frac{1}{4}$ years). The radial artery is small and tightly contracted. Shows type of irregularity and occasional appearance of anacrotic curves.

The italics are mine, and I would emphasise the fact that this authority assumes the omission of a whole cardiac cycle during the long pulse-pause. This supposition has been accepted as being the correct definition of what actually occurs.

The General Type of Pulse Irregularity in Tubercular Meningitis.—Sphygmographic examination of the pulse, however, lends no support to such a view, for the so-called "intermissions" are found to be due to a prolongation of the diastolic portions of some of the curves, of the same nature as characterise the ordinary type of youthful irregularity.

Frequent instrumental examination of the pulse in tubercular meningitis has convinced the writer that this is an accurate statement. There is no essential difference, appreciable to the finger, between the type of irregularity found in the early stages of this disease, and that which may be found in any healthy child whose pulse is slowing down from any cause.

Other cerebral lesions—simple meningitis, cerebral tumour, and abscess—may sometimes very closely resemble tubercular meningitis, and in order to make a distinction it is often necessary to examine each symptom in detail. Under such circumstances the sphygmograph may reveal certain pulse features which could not be ascertained without its aid, and which may be of considerable value in differential diagnosis.

A Special Feature in the Pulse Irregularity of Tubercular Meningitis.—In a typical case of tubercular meningitis, if the sphygmograph be used every twelve or twenty-four hours throughout the early stages of the disease, one may sometimes secure a tracing where the pulse-waves exhibit one particular feature which is not to be observed in sphygmograms obtained from most other cerebral affections (intracranial tumour excepted), for which it may be mistaken. The feature referred to is somewhat difficult to describe, but an examination of the tracings (Figs. 112-115) will clearly show the peculiarity to which it is desired to draw attention. In some of the curves the length of the systolic wave is shortened, and the second summit of this wave then rises to a higher level than usual above the first summit. This is equivalent to saying that occasionally the curves in the tracing become of the anacrotic or bisferiens type. The radial artery is always tightly contracted when such tracings are obtained, and the appearance of the sphygmogram suggests that the calibre of the vessel is undergoing variations, from vaso-motor influence, even while an observation is being made (see also Figs. 16 and 28). It cannot be certainly affirmed that this is a feature *peculiar* to the pulse of tubercular meningitis, or that it can be demonstrated in every case of that disease. When such a tracing is obtained, however, it is noted that it differs in this respect from the usual type of youthful irregularity. Otherwise the two forms of irregularity would be precisely similar.

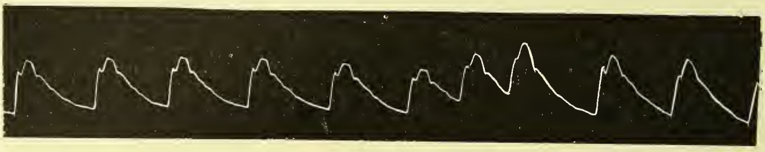

FIG. 113.—Pulse in tubercular meningitis (child æt. 2½ years). Radial artery contracted. (Anacrotic pulse.)

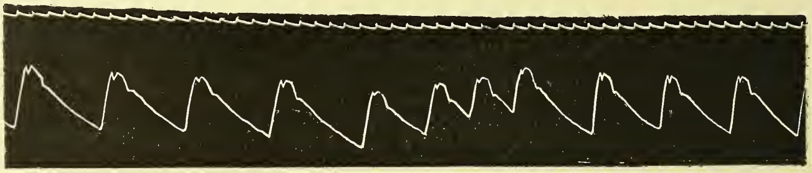

FIG. 114.—Pulse in tubercular meningitis (child æt. 2½ years). Radial artery cord-like. Shows the rather characteristic type of irregularity in this disease. (Anacrotic curves.)

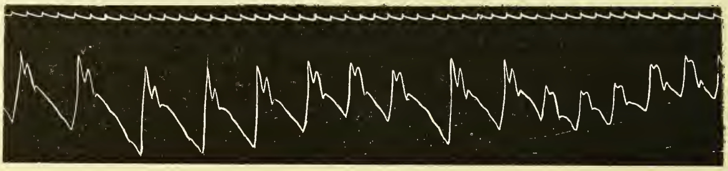

FIG. 115.—Pulse in tubercular meningitis (child æt. 2½ years). The radial artery is not so tightly contracted—temp. 100·2°. The pulse-curves are now of the bisferiens type, but the same type of irregularity is shown.

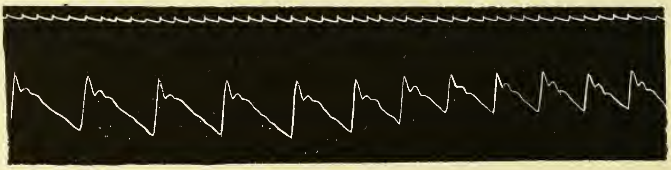

FIG. 116.—Pulse in tubercular meningitis (child æt. 2¾ years). To show the changes in pulse form in the course of a single tracing.

Changes in the Character of the Pulse during the Course of Tubercular Meningitis.—In some cases of tubercular meningitis, perhaps the remarkable variation in the character of the pulse-curve from day to day, or even from hour to hour, is the most striking thing noted. This is another suggestive point in the differential diagnosis of the disease. The pulse may be fairly regular, and may alter while it is being felt into a halting, irregular rhythm. Sphygmograms of the type shown in Figs. 116 and 117, where a series of large and small beats occur alternately throughout the tracing, are sufficiently remarkable to attract attention. One is tempted to believe that such appearances are of instrumental production, but this is not the case. When the slow, irregular pulse of tubercular meningitis is quickened from any cause, it, at the same time, becomes regular, and, in the final stage of the disease, becomes enormously rapid. During this period the vagus never, even temporarily, regains its control over the heart, and the pulse is *constantly* fast (Fig. 118).

During the early stages of the disease, when the pulse is slow, the sphygmogram is invariably one of the high-pressure type, even though the wave is excessively small and feeble. In the later stages of the disease, however, when the pulse becomes rapid, the pressure may fall, and the tracing is sometimes dicrotic.

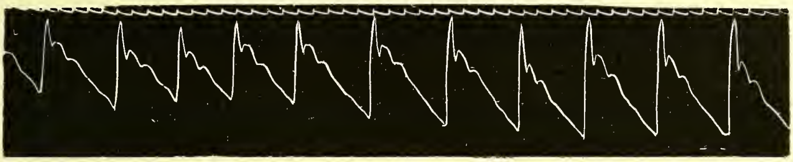

Fig. 117.—Pulse in tubercular meningitis (child æt. 3¼ years). To show the striking variations in the amplitude of the pulse-curves.

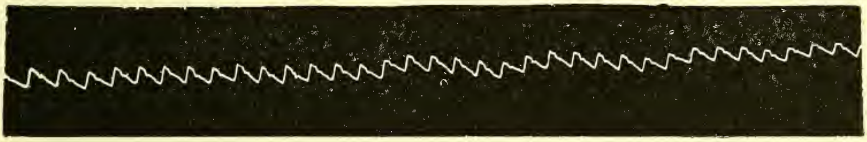

Fig. 118.—Very rapid pulse at the final stage of tubercular meningitis (child æt. 2$\frac{2}{12}$ years).

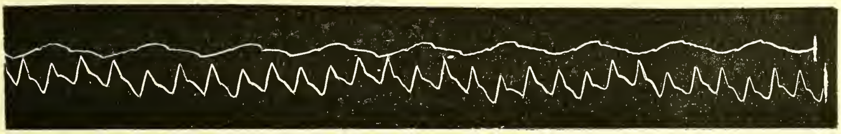

Fig. 119.—Very rapid pulse (160 per minute) showing respiratory variations from a child aged 2½ years with tubercular meningitis. Temp. 100°, resp. 48. (Upper tracing is of respiration.)

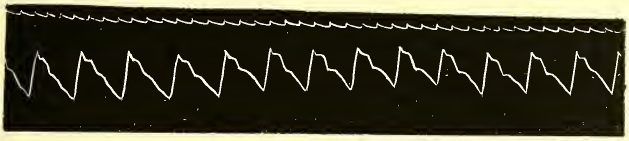

Fig. 120.—Pulse in simple basic meningitis (child æt. 3½ years). Shows fairly high pressure curves under slight pyrexia (temp. 100°), but is rapid and fairly regular. No contraction of radial artery.

With regard to the pulse in simple basic meningitis there appears to be nothing specially characteristic. It is commonly fast from the onset of the disease, which is generally sudden. Many of the children attacked are under two years of age, but even in older children the writer has never obtained tracings which presented any similarity to those of well-marked tubercular meningitis. It is often of fairly high pressure, and the form of the curve may not always alter under slight pyrexia (Fig. 120); but there is never the same remarkable contraction of the artery, and the pulse is at no time either so slow or so markedly irregular as in the tubercular variety. The form of respiratory curve obtained in some cases of simple basic meningitis has already been referred to as a point to be considered in differential diagnosis.

The Pulse in Pneumonia

I. The Pulse in Croupous Pneumonia.—The pulse in croupous pneumonia in early life shows some characters which are not usually observed in older children. Attention has already been drawn to the interesting fact that high temperatures in infants under one year of age do not render the pulse dicrotic. Therefore sphygmograms which are taken from babies suffering from acute croupous pneumonia indicate relatively high pressure, and one must not infer from this that the general state of the heart is satisfactory, and that the child is doing well (Fig. 121).

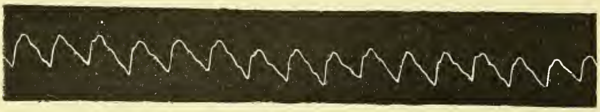

Fig. 121.—Pulse in croupous pneumonia; child 11 months old (relatively high pressure).

In children over one year of age, and under three years, tracings are sometimes obtained which indicate high pressure, and sometimes the pulse-curves are of the anacrotic type. But as a rule, in young children, sphygmograms taken at the onset of croupous pneumonia only show high-pressure characters over a comparatively short period. In a day or two, or sooner, the systolic wave appears as a single summit, and the dicrotic notch is well marked.

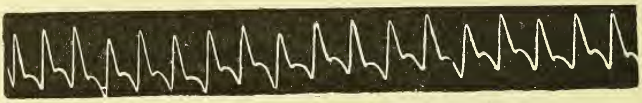

Fig. 122.—Typical pulse of croupous pneumonia at the height of the disease (child æt. $3\frac{1}{2}$ years).

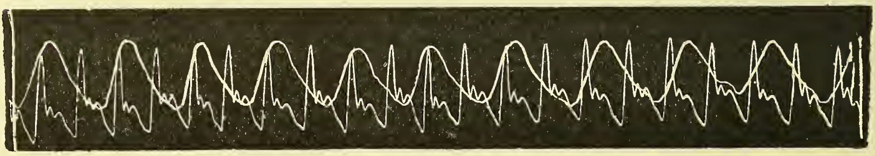

Fig. 123.—Simultaneous tracings of pulse and respiration in a typical case of acute croupous pneumonia at the commencement. Shows good arterial pressure. (Child æt. 8 years. Temp. 102°, pulse 120, resp. 60.)

In moderately severe cases of croupous pneumonia in young children the type of pulse-curve at the height of the disease is of the character shown in Fig. 122.

The State of the Arterial Blood-pressure.—The onset of acute croupous pneumonia in children does not seem to be characterised by a full, bounding, high-pressure pulse, as is often the case in young adults. The writer has made numerous observations on the state of the arterial blood-pressure in the pneumonias of children by means of the large Hill-Barnard sphygmometer; sometimes it is fairly high at the very commencement of the disease in children about five years of age and over, but only for a comparatively short period (Fig. 123); it soon falls, and tends to remain low.

The Relation of the Blood-pressure to the Post-mortem Appearances of the Lungs.—In croupous pneumonia of the so-called sthenic type, in healthy young adults, it is not unlikely that the greatly increased arterial blood-pressure at the invasion of the disease leads to an exudation of fibrin and corpuscles into the air vesicles of the lung. Professor Hamilton, from his large experience of post-mortem examinations, states that the lungs of young children who die from so-called acute croupous pneumonia do not present the same features in this respect as the lungs of adults who die of the same disease. Ten years ago he remarked to the writer that the relatively low blood-pressure in children during pneumonic attacks might partly explain why there was no throwing out of fibrin into the vesicles of the lungs. Observations on the pulse- and blood-pressure in acute croupous pneumonia in children tend to confirm this opinion.

The Special Tendency to a Fall of Blood-pressure in the Pneumonias of Children.—One of the most striking points about pneumonia of all kinds in children is the remarkable tendency for the blood-pressure to fall, and in *broncho-pneumonia* this is the main thing to guard against. To anticipate the, sometimes fatal, fall of blood-pressure is the chief object of our treatment.

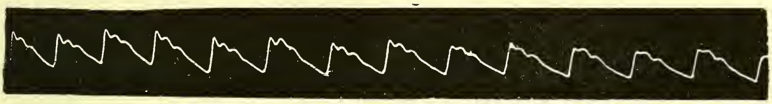

Fig. 124.—Pulse in croupous pneumonia shortly after the crisis in a favourable case. (From the same patient whose pulse is shown in Fig. 122.)

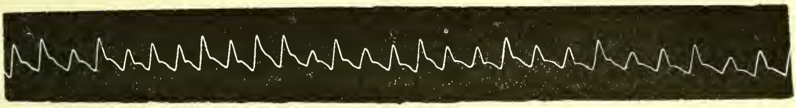

Fig. 125.—Pulse in croupous pneumonia in an unfavourable case. (Child æt. $2\frac{1}{4}$ years. Temp. pulse 160, resp. 84.)

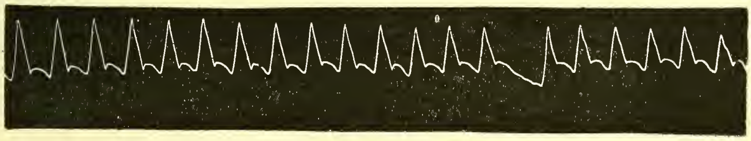

Fig. 126.—Pulse *of bad prognosis in* croupous pneumonia in the adult, before the crisis. This type of pulse, the occurrence of irregularity in the early stage of the disease, is generally of fatal significance.

Prognosis in Croupous Pneumonia.—In croupous pneumonia the main thing to note with regard to prognosis is that in favourable cases the pulse-pressure increases very shortly after the crisis occurs. The pulse then slows, and the youthful type of irregularity appears (Fig. 124). This slow, irregular pulse may continue for many weeks during convalescence.

In unfavourable cases the pulse-tracing indicates a falling pressure and becomes very rapid. The pulse-waves are of unequal size, and the dicrotic wave may disappear before death (Fig. 125).

The significance of pulse irregularity in relation to the prognosis of croupous pneumonia is an interesting matter. An elderly patient may habitually exhibit an irregular pulse; he takes pneumonia and becomes feverish. Under such conditions, according to Mackenzie, his pulse should become more regular; if it does not tend to do so the prognosis is bad. Another of Mackenzie's observations is of great practical importance. He states that in young adults suffering from lobar pneumonia with a temperature of 103° or over, the occurrence of pulse irregularity before the crisis is an invariably fatal sign. In these cases the pulse is a very rapid one, and the irregularity is either of the so-called "false ventricular" or "false auricular" type (Fig. 126). The "premature systole" may only occur at long intervals. In adults Mackenzie has also noted the fatal significance of a pulse which, shortly after the initial rigor, exhibits an absence of the dicrotic wave.

A pulse which shows the "premature systole" type of irregularity is, as already stated, excessively rare in children, yet, curiously enough, the youngest patient who showed such a pulse was a child two years old, and it was at the onset of an attack of apical lobar pneumonia (Fig. 127). The temperature was 102°, and the pulse 130 per minute, but the child was not much distressed. In a few days, after a good crisis, convalescence set in, and the pulse became slow and regular. The cause of the peculiar heart-rhythm was inexplicable, but it did not bear the same evil significance as in Dr. Mackenzie's cases.

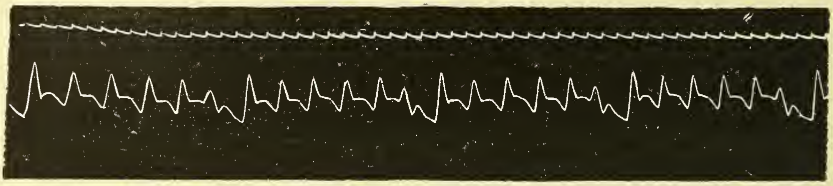

Fig. 127.—The same type of pulse as shown in Fig. 126, but occurring in a child æt. 2 years with a mild apical pneumonia; had no evil significance.

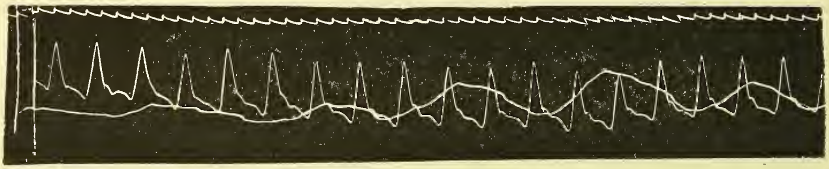

Fig. 128.—Typical pulse of broncho-pneumonia in the early stages of the disease (child æt. 7 years). Indicates lower blood-pressure than that of the croupous variety.

II. The Pulse in Broncho-pneumonia.—Sometimes in infants under one year of age, suffering from this disease, a dicrotic pulse may be found when the temperature is high. Dicrotism in the febrile pulse of young babies is most unusual, and the fact that it is found in broncho-pneumonia supports the belief that the blood-pressure tends to fall unusually low in this disease. Observations with the sphygmometer seem to show that the temporary initial rise of pressure, sometimes noticed in cases of croupous pneumonia, does not occur in broncho-pneumonia. The pulse-curve in this disease—except in infants under a year of age, for the reasons already mentioned (see page 215)—invariably indicates low pressure.

The Type of Pulse-curve in the Early Stages of Broncho-pneumonia.—The kind of sphygmogram obtained in the early stages is more markedly dicrotic than in the croupous variety (Fig. 128). In cases which are going on to a favourable termination the pulse-pressure shows indications of increasing, the pulse slows, and a prolongation of the diastolic periods of some of the curves is noted.

But in those cases which progress steadily to a fatal issue there is a type of pulse-tracing to be obtained which is highly characteristic. The pulse is exceedingly rapid, from 140 to 160, and the respirations are about 70 or 80 per minute. The pulse-waves are of various shapes, and show varying degrees of pressure, but the most important feature is the more or less complete disappearance of the dicrotic wave (Fig. 129). This is a sure indication that the blood-pressure has fallen to a dangerously low point.

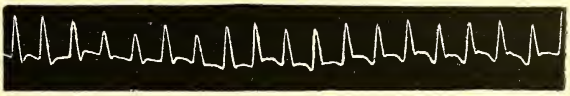

FIG. 129.—Pulse in broncho-pneumonia of fatal significance if it persists for several days (child 1¾ years old).

Fatal indications are afforded by this type of sphygmogram, especially if it be obtained in the early stages of the disease, and if it persists for several days. On several occasions this pulse feature has been observed in the broncho-pneumonic attacks of children at the height of the disease, but it was then quite a transient condition. Sometimes, however, this kind of pulse is found at a time when the child is apparently not very ill, and it persists day after day. The writer has never known recovery to take place under such circumstances. On one occasion the fatal event was predicted a fortnight before its occurrence, at a time when the child seemed to be in a fairly satisfactory condition, to judge from other symptoms. Therefore these sphygmographic appearances of the pulse in broncho-pneumonia are of great significance in prognosis, and this particular form of pulse-tracing may fairly be regarded as a *type* which experience has proved to be of decidedly bad omen.

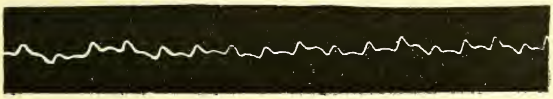

FIG. 130.—The worst type of pulse in pneumonia; pulse-curves of unequal size with *blunt* apices (child æt. 9 years).

One other point about this pulse is that the systolic wave may be either *pointed* or *rounded*, and the *sharper* the apex of the tracing the *better* the prognosis. The worst possible type of curve is that in which there is a blunt-pointed apex and a wave of very small amplitude. The pulse-curves are also of unequal size (Fig. 130). These are indications that the heart-muscle is failing, and probably that dilatation of the organ is commencing. Shortly before death in broncho-pneumonia a pulse-tracing showing these characters is often seen. Very similar tracings are obtained in cases of late mitral stenosis (Fig. 131), and also in children dying from auto-intoxication from the intestinal canal.

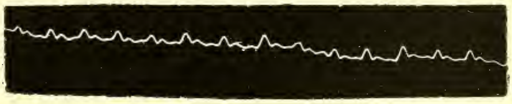

FIG. 131.—Same type of pulse as that of fatal pneumonia, from a case of late mitral stenosis.

There is a persistent tendency to failure of the blood-pressure in severe attacks of pneumonia in children. In the catarrhal variety this is especially the case, and if the fall is not arrested very grave symptoms result. In these cases the great lowering of the blood-pressure seems to be primarily due to an intense relaxation of the blood-vessels all over the body. The general vaso-motor tone seems to be entirely lost. This may possibly be due to a special toxin. The condition of the circulation seems to be somewhat similar to that found in a well-marked case of exophthalmic goitre, or the same state might be produced by great overdosing with thyroidin. In cases of severe broncho-pneumonia in children the myocardium may suffer, partly from insufficient nutrition, owing to inadequate blood-supply through the coronary arteries, consequent upon the lowered blood-pressure; and if we could counteract this extreme relaxation of the blood-vessels we should be fulfilling one of the first indications of rational treatment.

In this connection suprarenal extract may possibly be worthy of a trial, and a sterilised decoction of the medulla of the gland might be injected into a superficial vein by means of a hypodermic syringe. Or adrenalin might be used. These cases are so fatal in young children, and chiefly so from cardiac failure, that one would gladly welcome any new measure which could be adopted with a fair prospect of success.

Venous and Liver Pulsations

Until within recent years our knowledge of these forms of pulsation has been of the most meagre and unsatisfactory description; even the main features of the ordinary jugular pulsation had been misinterpreted both by clinicians and experimental workers. In 1896 Mackenzie published his luminous papers on "The Venous and Liver Pulses," wherein is to be found a full and lucid description of the whole subject. His researches stand alone, not only in the numerous new facts recorded, but also in the interpretation of them. In this article the writer is indebted to Dr. Mackenzie for permission to give a short summary of some of the main facts of interest in the study of the venous and liver pulses. For fuller information Dr. Mackenzie's recently published work must be consulted.

The right heart frequently dilates, and thus permits blood to regurgitate back into the auricle during the systole of the ventricle. The tricuspid valves are readily rendered incompetent, and the older physicians used to speak of them as "safety valves," because over-distension of the right ventricle was in this way naturally relieved. But incompetence of the tricuspid valves is not always associated with a pulse in the jugular veins, and the explanation of this fact is important, because herein is found the clue to the true interpretation of the various forms of venous pulsation. The explanation is that *the dilating auricle is interposed between the ventricle and the veins.*

From a study of the venous pulse we obtain information regarding the condition of two chambers of the heart, the right auricle and ventricle; the arterial pulse only indicates what the heart is doing during the time of the ventricular contraction. In cases of pulse irregularity the venous pulse reveals what is occurring in the various chambers of the heart during its irregular action, and forms the only accurate means of diagnosing the kind of arrhythmia present. Pulsation in the jugular veins is found in various forms of functional heart failure, in chlorosis, pregnancy, pernicious anæmia, etc.; but in such cases, however great the heart failure may be, there is never pulsation of the liver. The liver pulse occurs only when there is dilatation of the right heart secondary to mitral disease, and then the disease is always far advanced.

In the jugular vein near its junction with the subclavian there are two valves which in normal conditions prevent regurgitation of blood into the neck. During auricular systole the circular muscular fibres of the venæ cavæ, where they join the auricle, contract with sufficient power to act in the place of valves, and thus prevent regurgitation of blood into the veins. Distension of the right heart impairs the functions of these circular fibres, and a wave of blood is thus sent backwards with each auricular systole. The jugular valves are still between the contracting auricle and the vein in the neck, but they are readily rendered incompetent in some patients. When this happens a wave of blood is sent up the vein into the neck, due to and synchronous with the auricular systole.

The vein, after being filled, collapses as the auricle passes into diastole, and this collapse is the movement usually observed when the neck is inspected; it is found to correspond to the systolic portion of the arterial pulse.

If a graphic record be taken from the vein by means of the clinical polygraph, the movements can be accurately timed with the apex-beat, carotid, or radial pulse, and the causes of the various events can usually be easily recognised. Thus a wave preceding the carotid pulse can only be produced by the systole of the auricle. In like manner, when a wave occurs in the veins synchronous with the carotid pulse, it can be referred with certainty to the systole of the right ventricle. When the tracing shows a wave due to the auricular systole it frequently happens that there is also a wave due to the systole of the ventricle. The time of occurrence of the ventricular wave is delayed for a longer or shorter interval after the carotid pulse.

The venous pulse may thus be divided into two forms, viz. the auricular venous pulse and the ventricular venous pulse. The first is that form which presents distinct evidence of the functional activity of the right auricle. In this form there is also a wave due to the ventricle, and as it increases the auricular wave decreases and finally disappears, and thus the form called the ventricular venous pulse is developed. The ventricular venous pulse is but a more advanced stage than the auricular; and as during its development there is a gradual fading of the auricular wave, there is a period when such terms do not sufficiently denote the character of the pulse. But the terms are convenient for descriptive purposes. Similar types of pulses may be recognised in the liver.

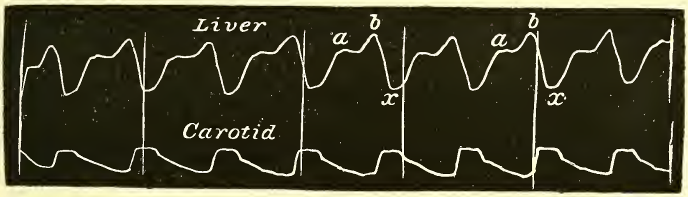

Fig. 132.—Tracing of an auricle liver pulse taken at the same time as the carotid pulse to show the large wave (*b*), which is due to the auricular systole. (Mackenzie.)

In Fig. 132 simultaneous tracings are given of the liver pulse and the carotid. The liver pulse is given in place of the jugular, as there are other movements communicated by the carotid, owing to its proximity to the vein, when taking a tracing of the jugular pulse. When there is a liver pulse it is always identical with the jugular pulse, the blood being sent from the auricle through the inferior vena cava. In this tracing it will be seen that there is a large wave (*b*) which immediately precedes the carotid pulse. At the same time that the carotid pulse appears, the wave (*b*) is falling, and the carotid pulse therefore corresponds with the collapse of the vein or liver. The wave (*b*) can only be due to the auricular systole.

In Fig. 133 there is a simultaneous tracing of the liver and jugular pulses. In the jugular pulse there is a small wave (*c*), which interrupts the fall of the auricular wave (*b*). This small wave (*c*) is really due to the carotid. When the carotid is very small and the jugular pulse very large, the tracing may not show this carotid wave. In Fig. 134 the carotid pulse is taken at the same time as the jugular, and the wave (*c*) is found to correspond exactly with the time of the carotid pulse. The wave (*c*) has, of course, nothing to do with the venous pulsation; it is simply due to the movement of the carotid artery in the neck (see p. 203).

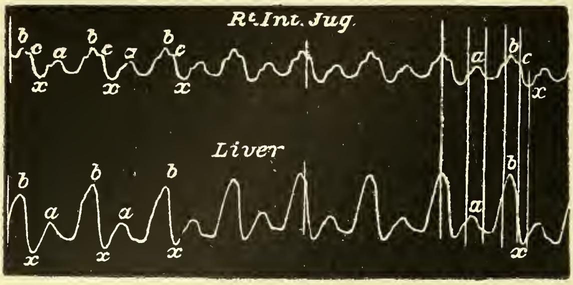

Fig. 133.—Simultaneous tracings of the venous and liver pulses, showing the wave (*c*) in the jugular pulse which is really due to the carotid impulse. (Mackenzie.)

Immediately following the auricular wave (*b*) there is a great collapse of the vein—(*x*) in the tracings. This is due to the sudden emptying of the vein into the auricle during the auricular diastole, and it is synchronous with the arterial pulse. This fall is interrupted by a second wave (*a*), which is called the ventricular wave. Mackenzie has clearly demonstrated the true cause of this wave, and it is due to the ventricular systole. It appears a little later than the carotid pulse, because the first part of the wave is absorbed by the dilating auricle. This is the important factor in the interpretation of the venous pulse; it is not till the auricle has filled that this wave appears.

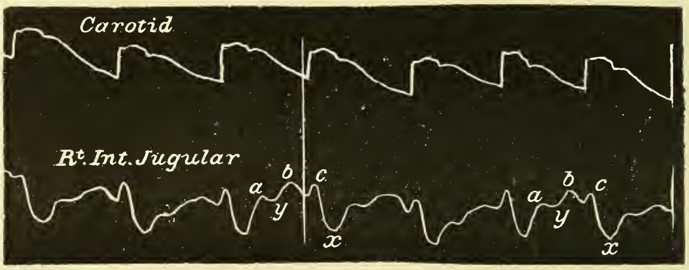

Fig. 134.—Simultaneous tracings of the carotid and jugular pulses, showing that the wave (*c*) corresponds exactly with the time of the carotid pulse. (Mackenzie.)

When this explanation is fully appreciated it is easy to understand how a venous pulse of the auricular type becomes converted into the ventricular form—how the ventricular wave enlarges when the auricular diminishes. The powerful right ventricle pumps blood into the thin, weak-walled auricle until the latter becomes enormously distended. Matters proceed until complete paralysis of the auricle occurs, and, according to Mackenzie, this is by no means a rare event, though it is not properly realised by observers. Before this stage is reached the auricle is still capable of contracting, and Fig. 135 represents a tracing where the liver pulse is taken at the same time

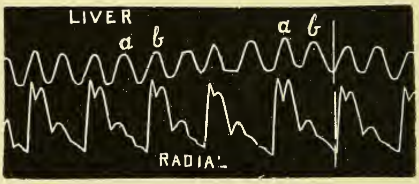

Fig. 135.—Simultaneous tracings of the liver and radial pulses. The liver pulse shows auricular (*b*) and ventricular (*a*) waves of equal size. (Mackenzie.)

as the radial pulse. The auricular waves (*b*) and the ventricular waves (*a*) are now about equal. A subsequent tracing from the same patient (Fig. 136) shows only one wave, and that wave is entirely ventricular systolic in time. There is absolutely no sign of auricular contraction. Dr. Mackenzie made a post-mortem examination on this case a month later, and found that the auricle resembled a thin-walled sac with a few strands of muscular fibres scattered over it. Patients who exhibit a venous pulse of this kind, a pulse demonstrating that the auricle has ceased to contract, may apparently live for many years. The auricle is then merely a reservoir for the blood during the ventricular systole.

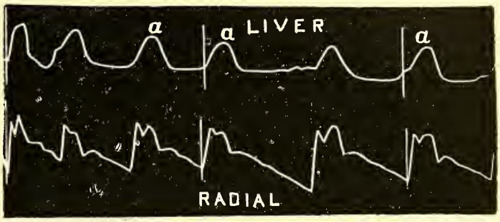

Fig. 136.—Simultaneous tracings of the liver and radial pulses The liver pulse shows only one wave, the ventricular (*a* The auricle is paralysed. (Mackenzie.)

A venous pulse of the auricular type may not signify much cardiac failure; but if the liver pulse is also present, then it is a sure indication of advanced heart mischief. The auricular venous pulse may be temporarily present when there is little deviation from the normal standard of health.

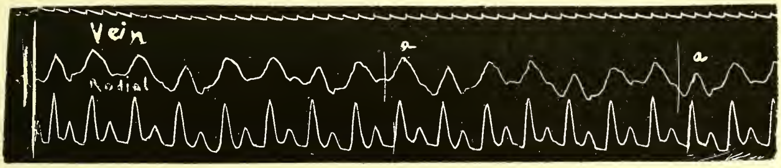

Fig. 137.—Venous pulse of the ventricular type in a boy æt. 9 years, suffering from advanced mitral disease with great dilatation and hypertrophy of the heart.

Venous Pulsation in Children.—Pulsation of the jugular veins is not a very uncommon phenomenon in children. In conditions of debility, and when there are symptoms of cardiac failure, it is not unusual to find flickering movements in the external jugular veins. Tracings from these movements cannot easily be obtained, but when there is pulsation of the internal jugular veins the wave is of sufficient magnitude to be graphically recorded. The auricular type of venous pulse occurs in children more frequently than is generally supposed, and it may exist whenever the right heart has become dilated from any cause. It is also sometimes a symptom of tricuspid regurgitation, and the writer recently obtained excellent tracings from the jugular vein of a child of eleven years suffering from mitral disease, and where a distinct systolic murmur was present over the tricuspid area. The ventricular type of venous pulse also occurs in children. In three cases of grave cardiac disease tracings were obtained simultaneously with the radial pulse. All the patients were boys who suffered from very advanced mitral disease, accompanied with extreme hypertrophy and dilatation of the heart. The venous tracing in Fig. 137 is of the ventricular type, but a pulsation of this nature must be seldom obtained at such an early age. The patient was under the care of Dr. John Thomson, who kindly permitted me to record the movement. After some weeks of treatment the boy was in a greatly improved condition, but at the time when the tracing was obtained his right auricle must have been temporarily paralysed.

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It is remarkable how frequently help of the most important kind in solving the medical problems that are from time to time presented to us is afforded by a systematic and habitual close observation of the eye. Clues are indeed frequently obtained by this method, which becomes a second nature to one who has had training in ophthalmic practice, of instantly appreciating the general condition of the eye movements as the patient sits before him, their relative position, lid movements, and pupil appearances—clues which often lead directly to a correct diagnosis of cases of nervous disease which might otherwise have been entirely overlooked. Perhaps the most obvious disease which, by means of the eye symptoms it presents, can be diagnosed frequently the moment the patient enters the room, is Graves' disease, in which the bulging eyes, widely open and showing white sclera above the cornea, with dilated pupils, and general aspect suggestive of intense terror, form a picture familiar to every student of medicine. Yet in cases of this disease, in which all the usual ocular symptoms are absent, with the goitrous swelling carefully hidden from view by frilling or a high collar in the sex which affords the large majority of these patients, how frequently the tachycardia and the nervousness that is only too apparent are wrongly ascribed to hysteria or excitement!

The movements of the pupil are governed chiefly by two antagonistic muscles, the sphincter pupillæ innervated by the third nerve, and the dilator pupillæ, which receives its nerve-supply through the cervical sympathetic. In addition to these influences the size of the pupil will vary with the amount of blood in the vessels contained in the iris, and small oscillations of the pupil occur with each heart beat. Thus congestion of the iris in iritis causes contraction of the pupil, while dilatation of the pupil is seen in chlorosis and other anæmias. In these latter, however, the dilatation is not alone dependent upon the condition of oligæmia, which is indeed not always present, but partly upon the stimulating effect of the venosity of the blood upon the pupil-dilating centre in the floor of the aqueduct. This effect is well seen in the rhythmic dilatation and contraction of the pupils which occur in Cheyne-Stokes breathing, either of cardiac or cerebral origin; dilatation of the pupil occurring at the beginning of the period of dyspnœa from simultaneous stimulation of the pupil-dilating and respiratory centres by the venous blood, the pupil contracting again towards the end of the dyspnœic period.

The *size of the pupils* varies with structural defects of the eyes, with the age and complexion of the person. In hypermetropia the pupils are said to be generally smaller than in myopia, owing to the constant tonic contraction of the ciliary muscle in the former, with the action of which contraction of the pupils is generally associated. Convergence is, however, more intimately associated with pupil contraction than is accommodation, but the centres for the three actions lie close together in the anterior portion of the third nucleus, and isolated paralysis of these three movements has been recorded. Habitual contraction may lead to permanent narrowing of the pupil, as is seen in engravers and etchers, jewellers, etc. If the act of convergence be produced without any accompanying contraction of the ciliary muscle, as can be done by placing two prisms, base outwards, in front of the eyes, and the gaze directed to a distant object, contraction of the pupils is seen to accompany the effort of convergence which is necessary to overcome the diplopia; whereas, conversely, if when the gaze is directed at a distant object two concave lenses are placed before the eyes, although accommodation is necessary to focus the object, yet the pupils do not contract.

In old age and in infancy the pupils are usually considerably smaller than in youth, and in light-complexioned persons with blue irides, the deficiency of pigment, by allowing more light to pass through and stimulate the retina, causes the pupil to be generally smaller than in people of darker complexion. Many diseases of the eye are associated with alteration of the size of the pupil and with the pupil-reflex to light, such as vitreous opacities, choroiditis, retinitis, optic neuritis, and atrophy, the pupil becoming dilated and losing its contractility to light roughly in proportion to the degree of loss of vision. In many persons, however, who have no perception of light remaining after retinal disease or optic atrophy, the pupil may still be observed to contract slightly under the stimulus of a strong light, owing to the fact that there are special fibres contained in the optic nerve, much smaller than the visual fibres, which are concerned in the conduction of the impulses for the light reflex.

In acute glaucoma the pupil is dilated, often oval vertically, and the light reflex may also be lost from the excessive intraocular pressure rendering the iris anæmic, and paralysing the nerve-endings in the sphincter pupillæ. *Many toxic influences affect the pupil.* In the algid stage of cholera the pupils may be widely dilated, whereas in typhus the pupils are generally very small. Numerous drugs also have power over the pupil either by direct action on the nerve-endings in the iris, or by affecting the pupil-contracting or pupil-dilating centres in the pons. Cocaine applied to the eye stimulates the endings of the sympathetic, and also contracts the vessels, thus producing dilatation of the pupil. Atropine also stimulates the dilator pupillæ, but also paralyses the endings of the third nerve in the sphincter pupillæ, causing the most extreme form of mydriasis. Eserine and pilocarpine, on the other hand, produce myosis by stimulation of the endings of the third nerve. In post-diphtheritic and alcoholic neuritis the pupils may be somewhat sluggish to light.

Opium, again, causes contraction of the pupil in most stages of its action, and chronic opium-takers may sometimes be detected by means of their pin-point pupils. Chloroform anæsthesia also causes contraction of the pupils in proportion to the degree of anæsthesia up to a certain point, beyond which rapid dilatation occurs from paralysis of the pupil-contracting centre. Deep sleep similarly produces contracted pupils by means of cessation of tonic action of the pupil-dilating centre. Psychical states in general react on the pupil through its centres in the pons, and the pupil may be seen to vary rapidly in size in different stages of emotion, anger contracting the pupil, and love causing dilatation, according to Sir Samuel Wilks. In proof of the effect of anger in contracting the pupil he quotes the contraction of the pupils that occurs in a parrot which has been annoyed. This case is, however, not comparable to that of man, for the parrot has voluntary power over the contraction and dilatation of the iris, and atropine has no effect in dilating its pupil. In hysteria and neurasthenia the pupils may be slightly unequal, though some inequality is often physiological, and in hysteroid states oscillations of the pupil, known as hippus, may be met with. This condition may also be met with in epileptics. A certain amount of rhythmic oscillation of the pupil is normal after exposure to light, strong contraction at first being succeeded by slight dilatation, the size of the pupil oscillating until it comes finally to rest in the contracted state. This is produced by the initial contraction shutting out a large proportion of the light entering the eye, and thus diminishing the stimulus; hence the succeeding dilatation, which again lets in more light, which again causes contraction. Occasionally a condition known as the paradoxical pupil reaction is seen, in which, under the stimulus of a strong light, though the pupil at first contracts, the succeeding oscillations are followed by considerable dilatation, which persists in spite of the continuance of the stimulus of the light falling on the retina. This paradoxical pupil reaction may be met with in the early stages of general paralysis of the insane, and, if well marked, will be therefore of bad prognosis.

In the elucidation of nervous diseases the condition of the pupil is often of the utmost importance, and it is therefore necessary to have a knowledge of the minute anatomy of the pupil-reflex arcs for contraction and dilatation, as well as of these centres. The light reflex, starting from the retina, passes up special fine fibres in the optic nerve, which undergo a semi-decussation at the chiasma like the visual fibres, passes up the optic tract of each side, and leaves the tract just anterior to the external geniculate body, passing by the anterior brachium to the grey matter of the anterior corpus quadrigeminum, where the fibres must make connection with nerve-cells, since ascending degeneration resulting from lesion of the optic tract cannot be traced farther than the grey matter on the surface of the corpus quadrigeminum. From this point to the third nerve-nucleus lying beneath the floor of the anterior end of the aqueduct its course is not certainly known, but in all probability it passes by means of Meynert's fountain decussation to the third nuclei of the same and of the opposite sides. The anterior end of the nucleus is specialised as the sphincter pupillæ centre, and it is generally supposed that the centres of the two sides are united by commissural fibres. From the nucleus the efferent part of the reflex arc is the third nerve, ciliary ganglion, and short ciliary nerves to the iris. Lesions of any portion of this reflex arc will have the effect of abolishing the pupil reflex, whether the endings of the third nerves are paralysed by atropine or in disease of the optic nerve. Owing, however, to the semi-decussation of the fibres at the optic chiasma, and perhaps also to the commissural union of the centres in the third nucleus, there is a consensual reaction of both pupils when only one is exposed to light. By means of testing both the direct and consensual reflex to light in each pupil separately, much information may be gained both as to the site of a lesion causing blindness, and of one producing loss of the light reflex. For example, in optic atrophy of one eye following gunshot injury of the orbit, light thrown on the blind eye will not produce contraction of either pupil, but light thrown on the good eye will cause brisk and equal contraction of both pupils, since the stimulus can pass up both optic tracts, and both third nuclei are affected. Both pupils will also contract equally on convergence. In such a case there is therefore loss of consensual pupil reflex to light in the good eye, whereas the consensual reflex is unimpaired in the blind eye. In such a case the injury must lie in the afferent portion of the reflex arc, and further, it must lie between the retina and the optic chiasma, since a lesion of the optic tract does not abolish the direct pupil reflex in one eye completely, but will affect the corresponding halves of both retinæ, producing the phenomenon known as the hemiopic pupil of Wernicke. When light is focussed on the anæsthetic half of either retina no pupil reaction results, but when focussed on either seeing half consensual pupil reaction in both eyes is observed. Knies has also theorised that this hemiopic pupil reaction must be obtainable in cases of lesion of the reflex fibres after they have left the optic tracts on their way to the third nerve nuclei, without any corresponding hemianopic loss of vision. This symptom has not been actually recorded, but might conceivably be met with in lesions of either anterior corpus quadrigeminum, or of its brachium. Any lesion damaging the visual path above the external geniculate body, whether in the optic radiations or in the cortex of the occipital lobe, will produce hemianopia without interfering with the pupil reflex, and the pupils will react normally to light even though the lesion be bilateral, producing total blindness.

The reflex arc for the sympathetic control over the dilating mechanism of the pupil is considerably more complex than that of the light reflex. The nuclear centre lies close to the third nucleus in the floor of the aqueduct, and external to it. Afferent impressions reach this centre along numerous paths; indeed, strong sensory impressions from almost any part of the body may result in stimulation of this centre. A usual way of testing the integrity of this reflex is to pinch the skin of the neck sharply, when dilatation of the pupil results. Equally potent, however, is a pin-prick on the inside of the nose, when the fifth nerve must serve as the afferent loop of the reflex arc. Intestinal disorders, such as worms and painful colic, are also said to react on the pupil in the same way. Moreover, impulses passing downwards from the cortex are continually affecting this centre, as is seen in the continual alteration in size of the pupil under emotion, irrespective of alteration in the intensity of light. It is possible, as some think, that there is a special centre for regulation of the size of the pupil in the neighbourhood of the head and eye centre in the posterior portion of the frontal lobe. Haab has described an "attention reflex" in which contraction or dilatation of the pupil occurs according as the attention is concentrated on a bright or dark object respectively on either side, while the gaze is fixed on a medium-coloured wall in front. With this may be compared the dilatation of the pupil which occurs on concentrating the thoughts on a long past event, and contraction on thinking of the distant future—a common "thought-reading" experiment. Gifford and Galassi described pupillary contraction on forced closure of the lids. Piltz finds this "orbicularis reflex" consensual, and present even in blind eyes and in cases with Argyll-Robertson pupil. The efferent path of the sympathetic impulses to the pupil is more definitely known; starting from the centre in the floor of the aqueduct, the fibres traverse the pons and bulb with the ascending root of the fifth nerve, and pass down the spinal cord in the lateral columns of the same side as far as the second dorsal root. They leave the cord at this level by the anterior root, pass by the rami communicantes to the inferior cervical ganglion, thence along the cervical sympathetic to the superior-cervical ganglion, whence they pass along the internal carotid artery, and so enter the cranial cavity, and reach the Gasserian ganglion. Reaching in this manner the fifth nerve, they accompany the ophthalmic division of this nerve, its nasal branch, and thence reach the ciliary ganglion, reaching the iris eventually by the long ciliary nerves. Lesions of the pons, bulb, and especially of the lateral columns of the cervical cord, as well as of the inferior cervical ganglion, and cervical sympathetic, such as thoracic aneurysm, mediastinal tumour, or enlarged glands in the neck, will produce paralysis of the dilator pupillæ and contracted pupil. Such contracted pupils do not dilate in shade, and the condition is therefore more obvious when both eyes are shaded from the light. They still contract slightly to light, both directly and consensually, but not quite so briskly as a normal pupil. Indeed, the reaction to light in this contracted pupil may be so sluggish as closely to resemble the Argyll-Robertson pupil. There is also present slight ptosis from paralysis of Müller's muscle, and the eye will appear slightly sunken. Anterior poliomyelitis, posterior sclerosis, and sclerosis of the crossed pyramidal tracts in the cervical region, do not produce sympathetic paralysis of the pupil, but gross lesions of the cord, which affect also the lateral column, as cervical myelitis, syringomyelia, and fracture-dislocations of the cervical spine will be accompanied by this symptom. This condition of sympathetic ptosis and contracted pupil will often afford the first clue in the diagnosis of syringomyelia from progressive muscular atrophy. Irritant lesions of the spinal cord in the lower cervical region at first cause dilatation of the pupil, later contraction from paralysis of the sympathetic fibres. Schiff described a paradoxical reaction, the pupil contracting instead of dilating on faradisation of the sympathetic; this I have seen in tabes. Dilatation of the pupil is said to occur in the early stages of aneurysm of the second part of the arch of the aorta. This I have never met with, the common condition being contracted pupil with slight ptosis from paralysis. Slight optic neuritis not infrequently accompanies sympathetic ptosis resulting from recent lesions of the cervical cord.

Since cocaine dilates the pupil by stimulation of the peripheral endings of the sympathetic in the iris, this fact has been taken advantage of in the differential diagnosis of complete and partial transverse lesions of the cervical cord. If the pupil will no longer dilate to cocaine, the inference is drawn that the sympathetic fibres are completely degenerated, and that therefore the cervical lesion is practically completely transverse. This symptom must, however, accord with the other facts bearing on this point to be of value; for example, if in a case of fracture dislocation of the sixth cervical spine there is complete motor paralysis below the lesion, and a fortnight later no dilatation of the pupils to cocaine, the inference would be that the lesion was completely transverse, if there were also absolute anæsthesia below the first intercostal space; yet if the patient could definitely feel a pin-prick on his foot or leg, it is obvious that the lesion cannot be completely transverse.

A most important symptom to recognise is that known as the *Argyll-Robertson pupil.* This was first described in the small pupils, or spinal myosis occurring in tabes, in which it was noticed that the pupils contracted normally to accommodation and convergence, but not to light, although vision might be perfectly good. The essential point, however, is the loss of the pupillary reflex to light in cases in which it can be demonstrated that the pupil is not fixed from iritic adhesions or other intra-ocular cause, and in which the afferent portion of the reflex in the optic nerve is uninjured, as proved by the vision being still preserved. The pupils are generally small, sometimes minute, so-called pin-point pupils, and there is then also sympathetic paralysis present, with loss of reflex dilatation from stimulation of the skin. Sometimes the pupils are unequal, in which case the loss of the light reflex is mostly more advanced on the side of the smaller pupil. Rarely, the phenomenon is uniocular, the other pupil remaining normal for a time, though in the majority of these cases both pupils are ultimately affected. In other cases, again, the pupils may be medium dilated, and occasionally widely dilated; there is then generally no contraction on convergence or accommodation. This symptom is found in the very large majority of cases of tabes, and in the later stages of general paralysis of the insane, in which the pupils may also be irregular in outline. It may be occasionally met with in other nervous diseases; I have met with it in progressive muscular atrophy, in lead palsy, in aortic aneurysm, and occasionally in patients presenting themselves for slight ailments, in whom no other sign suggestive of tabes or general paralysis could be found, but who had suffered previously from syphilis. As Gowers first pointed out, the true significance of the symptom lies in its indicating, with almost absolute certainty, previous syphilis. It is a sign of nerve degeneration resulting from the late effects of the poison, and is therefore by far the most commonly met with in tabes and in general paralysis, conditions of nerve degeneration dependent in great degree if not entirely on previous syphilis. Congenital syphilis may occasionally give rise to juvenile tabes or general paralysis, when this symptom will almost certainly be present. Argyll-Robertson pupil is perhaps the most constant symptom in tabes, and is probably the earliest recognisable symptom, being often well marked in cases of tabes, in which the knee-jerks may be still quite lively. Cases of tabes in which the pupil reaction is perfect are most exceptional, and the diagnosis should always be most carefully considered in such cases. Broadly speaking, the observance of this symptom will lead to the presumption that the case is probably one of tabes, or possibly general paralysis. If loss of knee-jerk be present in addition, the diagnosis of tabes will be confirmed. It is often quite easy to recognise the presence of this symptom almost at the first glance at a patient, inequality or immobility of the pupils, especially when facing the window, giving the clue, and leading to the actual test being made. In making the test, it is better to expose the eyes to strong diffused daylight than to light focussed from a lamp, the general stimulation of the retina being better from daylight, and there is then less chance of the pupils contracting with associated accommodation. Both pupils should be shaded together, and exposed to the light at the same time, in order to obtain the maximum of stimulus, and at the same time to compare the comparative briskness of contraction on the two sides, since marked diminution in briskness of contraction will be almost as significant as the fully developed symptom. The anatomical lesion underlying this loss of the light reflex has not yet been demonstrated, but presumably it is due to sclerosis of the pupil reflex fibres between the point at which they leave the optic tract and the sphincter centre in the third nucleus, perhaps in Meynert's decussation. It is thought by some that it is due to nuclear degeneration, and this must almost certainly be present when there is co-existent loss of contraction to accommodation. In most cases, however, the pupils contract briskly on convergence, and it is difficult to conceive how the sphincter pupillæ centre could be paralysed for the light reflex only, and yet work normally for convergence. We may perhaps assume that there is sclerosis of the endings of the fibres in Meynert's decussation where they impinge on the third nucleus, and that in some cases the degenerative process extends into the nucleus itself.

Alteration in the pupils is often to be observed in *acute cerebral disturbances.* At the commencement of an epileptic fit both pupils become contracted, an irritative phenomenon, while in the transient stage of flaccid paralysis, after the convulsions have ceased, the pupils are widely dilated, and insensitive to light. In meningitis the pupils are contracted in the first stage of cerebral irritation, unequal in the next stage of compression, and dilated in the third stage of paralysis. In acute mania and delirium the pupils are dilated, and often unequal or sluggish to light in alcoholic insanity. Cerebral hæmorrhage may produce inequality of the pupils, that on the side of the hæmorrhage being more often slightly dilated, especially if the bleeding has extended into the lateral and third ventricles. Hæmorrhage in the pons is frequently accompanied by minute contraction of the pupils, from irritation of the third nuclei, but this is not invariably present, and it is difficult to draw any precise deductions from the condition of the pupils in cerebral hæmorrhage, so variable are the effects. In cerebral tumour no alteration in the pupil will be seen unless there is pressure on the third nerve, when moderate dilatation and loss of reflex action will accompany the ptosis and divergent strabismus characteristic of paralysis of this nerve. Third nerve palsy from either nerve or nuclear lesion is common in tabes, and may be either partial or complete. When the ptosis and muscular impairment are only slight, the pupil reaction to light should not be completely lost, but if this is so, it will indicate the additional presence of the Argyll-Robertson pupil, which will often confirm an otherwise doubtful diagnosis of tabes in a case presenting itself for an incomplete paralysis of the third nerve. Fifth nerve palsy might be expected to be frequently associated with small pupil on the same side from involvement of the sympathetic fibres passing over the Gasserian ganglion, yet this is quite the exception, and I have only seen this association twice.

Purpura.

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DEFINITION.—The essential point in purpura is the occurrence of extravasations of blood into the skin, which are spontaneous and not due to injury. Strictly speaking, purpura is in all cases merely a symptom. In many instances the disease, of which it is a symptom, is fairly well known, and a great class of "symptomatic" purpura is therefore described. But in certain instances, more especially where hæmorrhage from mucous surfaces is associated with the cutaneous extravasation, the conditions upon which the hæmorrhage depends are unknown, and in default of such knowledge the term "purpura" is borrowed from the one striking symptom, and is used to designate "a disease" with the addition of various distinguishing adjectives.

CHARACTER OF THE CUTANEOUS HÆMORRHAGE.—Petechiæ form the chief feature in all kinds of purpura. They are red or purple spots which assume a rusty colour as they disappear. They commonly appear in successive crops. They may be thickly distributed over the whole surface of the body, and in fatal cases the serous and mucous membranes are generally found to be similarly affected. In size they vary from a mere speck to a spot half an inch in diameter. The smallest size is often seen as the result of flea-bites. In shape they are rounded, irregular, or star-shaped. They do not fade on pressure. Except in scurvy they have no relation to the hair-follicles. After their appearance they do not increase in size, except by confluence with neighbouring petechiæ. As a rule they are not raised above the level of the skin, but sometimes the centre is elevated into a papule. Occasionally some hæmorrhages are in the form of streaks (vibices). In association with petechiæ purplish bruises (ecchymoses) are often seen, sometimes measuring several inches in length. As these fade they show the brown and greenish yellow tints which are familiar in the traumatic bruise. Occasionally also large extravasations into the subcutaneous tissue are met with (hæmatomata).

ÆTIOLOGY AND PATHOLOGY.—From a consideration of the conditions under which a "symptomatic purpura" arises, we are justified in concluding that a purpuric eruption (excluding that of hæmophilia) may be produced: (1) by the presence in the blood either of bacteria themselves or of their poisonous products; (2) by the presence in the blood of some poison of non-bacterial origin, either introduced from without or manufactured in the body; (3) by some alteration in the formed or other constituents of the blood; (4) by vaso-motor influence. All instances of symptomatic purpura may be grouped in these four classes, which may be termed infectious, toxic, cachectic, and nervous respectively.

Although a bacillus such as that of plague, a toxin such as that produced by the bacillus diphtheriæ, a drug such as iodide of potassium, or a high degree of anæmia, may be spoken of as the cause of hæmorrhage, we are very far from understanding the exact method by which rupture of the vessel wall is effected. Doubtless some widespread deleterious influence is exerted by these agents upon the vessel. But in the production of petechiæ something more than this is needed. There must be some subsidiary local factors which determine the site of the hæmorrhage. Slight injury, sudden local alterations in blood pressure, capillary thrombosis, the unsupported state of a vessel, and the influence of gravity may conceivably contribute something towards the production of petechiæ. For example, in any purpuric state the prick of a needle will produce a hæmorrhagic spot. Gravity certainly plays a small part in certain cases of recurring arthritic purpura. Moreover, it has been shown by Unna that the point at which the cutaneous vessel ruptures is its point of least resistance. Rupture occurs in the lower part of the cutis, where the vessels lose their adventitia and media, and practically become capillaries without obtaining the support of the rigid cutis.

Various changes have been described in the vessel wall, such as endarteritis, hyaline and amyloid degeneration. It is more than doubtful, however, whether such changes would be favourable to bleeding. At any rate, in view of the clinical history of the sudden appearance of petechiæ in previously healthy individuals, such an explanation is now generally discarded.

Histological evidence as to the local cause of petechiæ is scanty. Thrombosis of small veins has been observed, but considering the freedom of anastomosis of cutaneous vessels, this cannot be regarded as important. Capillary emboli have been found in purpura dependent upon generalised sarcoma. A more promising explanation lies in the bacterial emboli, which, with or without capillary thrombosis, have been found in many cases of purpuric eruption appearing in infectious and septic diseases. On the other hand, while careful search has failed to reveal such an appearance in the hæmorrhagic spots of variola and diphtheria, the capillaries in the papillæ of the skin in scarlet fever have been found plugged with cocci without the occurrence of any hæmorrhage. The evidence is not strong enough to bear a conclusion.

The conditions, however, under which a symptomatic purpura occurs are known, and have been already enumerated. We may go so far as to suppose: (1) that in all of them, perhaps even in the unimportant nervous class, a circulating poison or an altered blood-state sets up in small vessels and capillaries a preparatory change in the direction of impaired vitality and loss of cell-cohesion, the exact nature of the change being unknown; and (2) that in this state various local factors determine rupture and extravasation of blood.

Our knowledge of the origin of "purpura as a symptom" is thus imperfect. When, however, we consider the nature of "purpura as a disease" we are reduced to pure hypothesis. The age-incidence of all forms of the disease is the only well-defined fact, the liability of children and young adults being very prominent. Both sexes are affected, and no great difference in their liability is noted. The family history throws no light on the ætiology, and no clue is gained from the previous history or surroundings of the patient. A review of a large number of cases leads to the provisional recognition of five forms of the disease, which are named simple, Werlhof's, arthritic, Henoch's, and febrile purpura respectively. It must be remembered that this classification is the outcome of purely bedside study. These forms may prove to be degrees or varieties of one disease, or they may be shown to be as distinct one from another as typhoid from typhus. To decide the question of their relationship there is needed a far deeper knowledge of their bacterial and chemical conditions than we now possess.

It will be noted that these five forms have many important points in common, each one, however, possessing some characteristic feature. In (1) simple purpura the hæmorrhagic tendency is almost confined to the skin, and the illness is mild and ends in recovery. In (2) Werlhof's purpura all mucous membranes and many viscera share in the tendency, and the illness becomes more severe, is often of longer duration, and may end fatally. In (3) arthritic purpura joint-pains are added to the hæmorrhagic element, and a proneness to recurrence becomes a prominent feature. In (4) Henoch's purpura severe colic and visceral hæmorrhage are additional symptoms. In (5) febrile purpura we have a well-defined severe disease approaching closely in type to a specific fever, such as small-pox, with pyrexia and a tendency to necrosis of certain tissues.

It is true that examples may be picked out from these various forms, which, placed side by side, will present strongly differentiating features. But it is equally true that, if a large series of cases is studied, instances are met with which seem to lie as links between them. At any rate, on the ground of clinical affinity, we are justified in looking upon simple purpura and Werlhof's purpura on the one hand, and arthritic and Henoch's purpura on the other hand, as forming two large groups, while the febrile form lies somewhat apart from them both.

As regards their causation there is abundant room for speculation. Nothing certain is known, but their close analogy with such instances as iodic purpura (toxic) and diphtherial purpura (infectious) compels us to regard them as coming under one or other of these two heads. Febrile purpura bears such a close resemblance to a specific fever that many attempts have been made to prove its bacterial origin. Their failure need not militate against the view. Bacteria of many kinds have been found in the blood and tissues, but the observations are vitiated by the fact that they were made some time after death. Their importance is not necessarily increased by the fact that the injection of cultures of these organisms has produced hæmorrhagic septicæmia in animals. Among these microbes are streptococcus, staphylococcus, a capsulated bacillus belonging to the colon-group, and other bacilli not classified. The blood, if taken direct from a vein during life, is generally sterile. Both streptococcus and staphylococcus have, however, been grown from it, but considering the common existence of a sloughing process in the mouth or throat or elsewhere in these cases, their presence cannot be regarded as necessarily meaning more than the supervention of a septicæmia. The common failure to find micro-organisms in the blood is not surprising, if we consider that the specific organism of so many of the recognised specific fevers is still unknown.

A. Symptomatic Purpura

Excluding hæmophilia the conditions, of which purpura is a frequent or occasional symptom, may be grouped in four classes. For the most part the form of hæmorrhage is the petechial eruption.

(1) *Infectious.*—Nearly all the specific fevers may be attended by a purpuric eruption, especially small-pox, diphtheria, measles, scarlet fever, and cerebro-spinal fever. Such an eruption betokens unusual severity in the disease. In typhus the rash is always of this nature. In typhoid fever petechiæ and vibices have been rarely seen. Petechiæ are not

uncommon in yellow fever and in plague. They occur in malignant endocarditis, pyæmia, and septicæmia; more rarely in syphilis, gonorrhœa, malaria, pneumonia, and erysipelas.

(2) *Toxic.*—Snake-poison produces large extravasations of blood into the skin, as well as hæmorrhage from mucous surfaces. A copious petechial eruption may follow the use of diphtheria antitoxin. A large number of drugs can produce petechiæ. Phosphorus, iodide of potassium, chloral, arsenic, quinine, mercury, salicylic acid, copaiba, ergot, belladonna, antipyrin, and opium and its alkaloids, may be included under this head. In phosphorus-poisoning hæmorrhage often occurs into the skin as well as from mucous surfaces. Iodide of potassium will produce in a few exceptional individuals an attack which closely resembles purpura simplex. As regards the other drugs enumerated such an effect is exceedingly rare. Petechiæ are also not uncommon in certain ill-defined states of poisoning, such as arise in nephritis, cirrhosis of the liver, and malignant jaundice.

(3) *Cachectic.*—A purpuric eruption is occasionally met with in cases of generalised sarcoma. A few petechiæ are not uncommonly seen on the lower extremities in cases of advanced phthisis or carcinoma, and in fact occasionally just before death from any form of long-standing disease. They may appear also in extreme old age. They are common in leucocythæmia, pernicious anæmia, and lymphadenoma. In scurvy and in scurvy-rickets, petechiæ, ecchymoses, and large subcutaneous extravasations of blood are common phenomena.

(4) *Nervous.*—Petechiæ occasionally occur in locomotor ataxy, especially in association with lightning pains. They have been seen also in myelitis, alcoholic neuritis, and neuralgia, and even in hysteria after severe emotion or over-excitement.

B. Purpura as a Disease

Symptoms and Course.—(1) *Simple Purpura.*—This form is almost confined to children of both sexes under the age of fifteen. The family history throws no light on its causation, but it is noteworthy that occasionally more than one child of a family is attacked. The surroundings of the child seem to play no part in the origin of the disease, for it frequently appears in children of good position, as to whose diet and life no fault can be found. In most cases the child appears to be healthy and well-nourished up to the onset of the symptoms. Sometimes it is ill-nourished or rickety. It may be noted that the attack is sometimes preceded or ushered in by diarrhœa, and occasionally indigestible or doubtful food, such as sausages, has produced gastric disturbance a day or two before the onset. Herpes has been known to appear on the lips at the beginning of an attack.

As a rule, without any appearance of ill health, the first thing which attracts attention is the appearance of petechiæ. They may be few at first, perhaps appearing in the first place about the neck as often as anywhere, but successive crops are added, until nearly the whole surface of the body is thickly studded with red, purple, or brown spots, having the characters already described. Large patches are sometimes formed by confluence of petechiæ. The face may be affected as well as the trunk and extremities, but the palms of the hands and the soles of the feet usually remain free. A few petechiæ may often be seen inside the lips and on the palate and tongue. They rarely if ever occur on the conjunctivæ or retinæ. In very slight cases they may be confined to the lower extremities. Rarely some red wheals are present among the petechiæ. Ecchymoses are common, and are readily produced by any rough handling. Hæmatomata occasionally develop, especially about the buttocks, thighs, and calves, and a bluish black brawny mass as large as a man's hand is sometimes met with in these situations. On such a mass a bulla containing sanguineous fluid may be formed, but this appearance is not so common here as in the febrile form of purpura. Close observation will sometimes detect a little œdema of the backs of hands and feet. In a few cases there may be some slight epistaxis at the beginning of an attack, or slight oozing of blood from the gums, but with these exceptions the hæmorrhage is confined to the skin. Occasionally there is evidence of slight pains in the joints.

In all cases the general condition of the child is in striking contrast with the cutaneous appearance. Often there is no indication or feeling of ill-health whatever, and all functions are naturally performed. Sometimes there is loss of appetite and a little restlessness, and perhaps for a few days the temperature may reach 100° in the evening. The child is, however, often pale when it comes under observation, and sometimes the anæmia increases during the illness, the red corpuscles falling as low as 3,700,000 per cmm. The leucocytes show no change in number or quality. There is no affection of the joints, no morbid appearance about the tonsils, and no evidence of intestinal disturbance beyond the occasional initial diarrhœa already mentioned.

Recovery is rapid and uniform, the length of the illness seldom exceeding a fortnight. No tendency to recurrence can be traced.

(2) *Werlhof's Purpura.*—This form, if we adhere to Werlhof's description of it, written in the 18th century, is a rare disease. It is clear, however, that his description must be amended in two important particulars. But though more cases are thus brought under the term, it still remains comparatively uncommon.

All that has been said of purpura simplex concerning the age and previous history of the patient, and the mode of onset and the early symptoms, holds good for this "morbus maculosus" of Werlhof. As a rule, it is not until a more extensive hæmorrhage has set in, and the illness assumes a severe aspect, that the diagnosis of the simple form is given up, and the more serious type of disease is recognised. The distinction between them is artificial and unnecessary.

The disease has therefore a gradual onset. For some days, or less commonly a week or two, crops of petechiæ continue to appear, perhaps the nose bleeds spontaneously on one or two occasions, and a little blood-clot may be seen between the teeth. The patient is anæmic, but as a rule presents no other evidence of illness. The hæmorrhagic tendency then rapidly increases. Epistaxis may be severe, and may necessitate plugging of the nostrils. The gums ooze freely, but if the adherent clot is removed they are seen to be pale and not swollen. Blood is vomited, and appears in the stools and in the urine. There may be expectoration of red blood, or of a blood-streaked sputum. Bleeding from the uterus and from the auditory meatus may occur. Hæmorrhages into the retina are not uncommon. Ecchymoses and hæmatomata may appear in various parts of the body. The tongue remains clean and moist, there is little or no pyrexia, and the appetite is commonly maintained. The blood shows the changes associated with loss of blood, and the red cells usually fall below 2,000,000, and sometimes below 1,000,000 per cmm. The waxy pallor of the skin is striking, and the main complaint of the patient is the feeling of faintness.

According to Werlhof's description the hæmorrhagic tendency ceases at the end of five or ten days, and rapid recovery ensues without complication.

Both these points must be modified in the light of wider experience. In the first place, the disease may run a much longer course. A patient may present the symptoms above described with hardly any intermission for at least two months, and with intermissions a case may occasionally run on for a year. In the second place, a fatal event is by no means uncommon, and the illness must always give rise to anxiety. By the continuance and profuseness of the hæmorrhage the anæmia reaches danger-point. The patient becomes, not restless, as is the case after a single large hæmorrhage, but apathetic and drowsy, and so dies exhausted, or at any point in the illness hæmorrhage into the brain, or upon its surface, may prove fatal.

In young children cases of great malignancy have been observed, and have been termed "purpura fulminans." With a sudden onset the cutaneous and visceral hæmorrhages are overwhelming, and death occurs in two or three days. In a recorded case, still more acute, no visceral hæmorrhage occurred, but the cutaneous hæmorrhage was extensive. Within a few hours all four limbs were swollen and discoloured by infiltrated blood, and the child died within twenty-four hours of the onset.

(3) *Arthritic Purpura.*—This form is a disease of adolescence and early adult life, and it is perhaps more common in males than females. The patient suffers for a few days from slight or severe pain in various joints, especially the knees, ankles, elbows, or wrists. Sometimes the joints are swollen and tender, but the pain may be severe, even when there is very little evidence of inflammation of the joint structures. Up to this point the condition will be regarded as a subacute rheumatism. Petechiæ now appear. As a rule, they are not distributed over the whole body, as in purpura simplex, though a few may be scattered over the trunk, and even on the mucous surface of the lips. They occur mostly on the lower extremities, especially on the shins and ankles, and they often show a tendency to be aggregated around an affected joint. Their distribution is symmetrical, as is the joint affection. In this form of purpura the centre of the hæmorrhagic spot is often elevated into a papule, which is commonly visible owing to its pallor. Sometimes in the centre of a spot may be seen and felt a pale spherical nodule, which is found on microscopical examination to consist of decolorised blood-clot. On the larger hæmorrhagic patches blebs filled with blood-stained serum may develop, and occasionally a little oozing will occur, so that a patch becomes surmounted with a crust of dried blood. Ecchymoses may often be observed, but in most cases the prevailing type is the simple petechial eruption. Slight œdema of feet and shins, or of backs of hands and forearms, is not uncommon. In some cases there is slight pyrexia, but often the temperature is normal throughout the illness. There is very little constitutional disturbance. Sweating is not a marked symptom, except in severe cases, and the skin is often dry and harsh.

The articular pains subside in a few days; the petechiæ, which appear in successive crops, become rusty and fade, and the patient may be well in a few weeks. But there is a strong tendency to recurrence. Though the patient remains in bed under treatment, the same phenomena, articular and cutaneous, are often repeated at an interval of a few days, and similar attacks, slight though they are, may carry the illness over many weeks. Even when the natural tendency to recurrence seems to have subsided, it will often be found that the first attempt to get the patient out of bed will result in another attack, and some months may elapse before the patient can pass the whole day in the erect attitude. In these later attacks the petechiæ are the marked feature. The articular pains may be very slight, often only stiffness is complained of, and as a rule there is no pyrexia.

The relation of this affection to acute rheumatism is uncertain. Strong arguments against any connection between the two conditions are the immense disparity in the frequency of their occurrence, and the moderate and often trifling nature of the joint affection. And as Scheby-Buch has pointed out, there is no form of purpura which does not occasionally present articular pains, and yet the term "rheumatic" can hardly be extended to all of them. Further, similar articular pains are often met with in cases of acute septicæmia, and do in fact sometimes lead at first to an erroneous diagnosis of rheumatism.

Under the head of arthritic purpura must be provisionally included certain cases which are of less common occurrence, but of sharper onset and greater severity. As regards the condition of the joints and the general course of the illness, they do not require separate description. But they present some peculiar features. In the first place, wheals are conspicuous among the petechiæ, whence the name "purpura urticans" is derived. The second characteristic is the extensive œdema. The eyelids, cheeks, alæ nasi, lips, and chin may be enormously swollen and tense, studded with petechiæ or discoloured with ecchymoses. The hands and feet and the neighbourhood of any joint may present a similar appearance. The writer has seen the penis red and œdematous, with a wheal and abundant petechiæ on its surface. In these cases pyrexia is often more marked. The urine may contain blood or albumin. Rarely blood appears in the stools. Diarrhœa has occasionally been noted. It should be noted that tonsillitis may usher in such an attack, and even when no throat symptoms are complained of the fauces are often found to be reddened. Endocarditis, pericarditis, and pleurisy have occasionally been noted; but in these cases there is a previous history of acute rheumatism.

(4) *Henoch's Purpura.*—This variety of purpura, which was described by Henoch in 1874, is most common in young people, the majority of cases occurring between the ages of seven and fifteen, and it is rare after thirty. Males seem to be more liable than females. Nothing is known as to its causation. It appears in children of good position, as well as in those who live under unhealthy conditions.

In its main features this form bears a close resemblance to arthritic purpura. The patient complains of vague aches and pains, such as occur at the onset of most specific fevers, with some feeling of illness. Soon one or more joints become painful, with little or no external evidence of inflammation. The appearance of slight œdema, the eruption of petechiæ, and sometimes of ecchymoses and wheals, and perhaps a slight rise of temperature, complete the resemblance to arthritic purpura.

After a few days, however, certain special symptoms are added. The child has paroxysms of severe abdominal pain, with obstinate vomiting and at first constipation, so that the picture of lead colic is recalled. But the vomit later is found to contain blood, diarrhœa generally sets in, the stools being black with altered blood; epistaxis is not uncommon, and there may be a little oozing from the gums. The pain is undoubtedly severe, the child cries aloud in the attacks, and there may be some collapse, the face becoming drawn and the pulse quick and small. The pain is generally referred to the umbilical region, and the abdomen is retracted and tender. Occasionally an intense nephritis is added. The urine becomes scanty and contains blood and a large quantity of albumin. Death may ensue with all the symptoms of uræmia. There is often slight pyrexia at the height of the attack, but the temperature may be normal throughout the illness. In fatal cases the spleen is found to be swollen, and its enlargement has been detected by percussion during life. Endocarditis and pleurisy have been noted in one case, but their occurrence may be attributed to antecedent rheumatism. As a rule, the articular pains, the petechiæ, and the gastro-intestinal symptoms appear in the sequence given.

Here, as in arthritic purpura, there is a strong tendency to recurrence. After a day or two of the gastro-intestinal symptoms rapid improvement sets in, only to be followed in a few days or weeks by a repetition of the attack. Sometimes a series of such attacks will prolong the illness into several months. Rarely an interval of many months elapses between attacks. Ultimate recovery may be expected as a rule, but it must be remembered that the nephritis may prove fatal, and that in one recorded case death occurred from perforation of the stomach on the fourth day of a second attack.

(5) *Febrile Purpura.*—This form is occasionally seen in young children; it is most common in adolescents, and it is rare after the age of thirty. Males seem to be more affected than females. As with the other forms of purpura no constant factor can be detected in the history of the patient or of his family.

As a rule, the sudden appearance of petechiæ, or of epistaxis, or of oozing from the gums, brings the patient under observation. On inquiring it is sometimes found that for a few weeks, or even months, the patient has not been in good health, pallor, loss of appetite, and listlessness being noticeable. Whether such a history is given or not it will generally be seen that the patient is already extremely pale. In rare instances the patient has been previously subject to epistaxis, and he may even have noticed a petechial eruption on a small scale on one or two occasions in the previous year. Sometimes, however, the onset is as sudden as in any specific fever. For example, a telegraph boy, whose history and appearance testified to perfect health, was seized with vomiting and malaise at mid-day. At 4 P.M. he was obliged to take to his bed. On the next day, without any fresh symptoms, he was unfit to get up. On the following day petechiæ appeared, and death took place in twelve days from the onset.

Whether the onset is sudden or gradual, after the appearance of the first hæmorrhagic symptom the illness proceeds rapidly and uniformly to a fatal end. The petechiæ appear in crops all over the body, thickly or thinly, showing no characteristic distribution. Ecchymoses are common. Of frequent occurrence are tender, bluish red raised patches, an inch or more in diameter, with a zone of bruising around. On such a patch a bulla containing clear or blood-stained serum is often developed, and this on breaking gives rise to an ulcer from which a thin, sanguineous fluid exudes. Such an ulcer may grow deeper by progressive necrosis in spite of all bactericidal treatment.

The mouth is always affected in some degree. Petechiæ can always be seen, and they are here apt to give rise to small gray-capped ulcers. Large sloughy patches are generally found inside the cheeks, and gangrene of the gums at one or more spots is a common occurrence. Neither of these phenomena can be attributed to previous hæmorrhage. Still less can such an explanation be offered as regards a progressive uncontrollable sloughing of one or both tonsils which is not uncommonly observed. Gangrenous ulceration has been known to affect soft palate, epiglottis, and arytænoid folds. The breath is generally offensive, and it may be exceedingly fœtid. The submaxillary glands are usually enlarged.

Slight continual oozing from the gums is a nearly constant symptom, and the mouth is unclean from the presence of decomposing clot. The gums are pale and not swollen. Epistaxis is common, and it may necessitate plugging of the nostrils. Retinal hæmorrhages are often observed. If sickness occurs, as is often the case, the vomit may contain a little altered blood, but hæmorrhage from the gastro-intestinal and urinary tracts is often entirely absent, and it is never a prominent symptom. Slight albuminuria may appear, probably attributable to the anæmia, and systolic murmurs are often developed at the base and apex of the heart from the same cause. Enlargement of the spleen has been detected by percussion. Joint-pains may be complained of without external evidence of inflammation. The bowels are apt to be loose.

Pyrexia is always a striking feature. It is often present when the patient first comes under observation. Sometimes, however, the first crop of petechiæ is not attended by a rise of temperature, and in such cases a diagnosis of purpura simplex may be made and a favourable prognosis may be too hastily given. The temperature ranges through 2 or 3 degrees daily, the maximum being generally at least 103°, sometimes 104° or higher. The patient sometimes falls into the typhoid state. Often, however, he does not present the usual febrile aspect, but he is extremely pale and blanched, while the tongue does not grow dry, and is often surprisingly clean. He is generally sleepy, but when roused the mind is clear. He is often singularly hopeful, and even when death is near may complain of nothing but faintness and weakness. The blood presents no change, beyond great diminution of red cells. Leucocytosis is slight or absent. The red cells are usually at least 50 per cent below the normal, and sometimes much below this point. A drop to 390,000 per cmm. has been observed. It must be noted that the anæmia is often quite out of proportion to the loss of blood, and that it is sometimes extreme when a scanty crop of petechiæ and a little oozing from the gums represent the total amount of hæmorrhage. The amount of hæmoglobin falls equally with the number of red cells.

The real duration of the illness can hardly be estimated, but death commonly occurs during the first, second, or third week after the patient comes under treatment. It is doubtful if recovery ever takes place. The immediate cause of death is generally cardiac failure.

Morbid Anatomy.—After death petechiæ are found to be as widely distributed inside the body as on the skin. In many cases all organs and tissues are thickly strewn with them. Sometimes one part is more affected than another, but the serous membranes and the heart seldom if ever escape. The whole surface of the stomach, and large tracts of the intestine, may be reddened with innumerable petechiæ, which sometimes fuse into extensive hæmorrhagic patches, especially in the rectum. The mesenteric glands are generally pink, and slightly swollen. Hæmorrhage may occur into the brain tissue, and extravasations are often abundant in the pia-arachnoid. Œdema, or broncho-pneumonia, and collapse may be present in the lungs. All viscera, as a rule, are exceedingly pale, though the kidneys after death from Henoch's purpura may present the usual appearance of an acute nephritis. The heart-muscle and liver are soft and pale, and iron-containing pigment may sometimes be demonstrated in the outer zone of the hepatic lobules. After death from febrile purpura the spleen is generally found to be enlarged. In one case it weighed twenty-three ounces. The marrow in the heads of the long bones has occasionally been noted as puriform in appearance, consisting almost entirely of fat, but it is uncertain whether this change is of common occurrence.

Microscopical examination shows that the hæmorrhage occurs mainly by rupture of vessels, and not by diapedesis, though the latter process may play some part. It has been mentioned that the site of the hæmorrhage is generally the lower part of the cutis. In horizontal sections through petechial spots the remains of ruptured vessels may be seen among the extravasated corpuscles in the form of streaks of connective tissue and endothelial plates, which are bent to a common centre.

Treatment.—In symptomatic purpura no special line of treatment can be laid down. If it occurs in association with specific fevers it usually indicates a high degree of toxæmia, and so far as possible this blood-state and its effect on the heart must be met. In the other cases it is sufficient to recognise the cause.

In simple purpura little is required beyond rest in bed and tonics, among which arsenic is to be preferred. Great care must be taken from the outset in view of the fact that the early stage of the graver forms of the disease may be indistinguishable from a simple purpura. In arthritic purpura anti-rheumatic treatment may be adopted, though it is doubtful if the course of the disease is thereby shortened. Complete and prolonged rest in bed is essential. In Henoch's form opium will be found necessary. When danger arises from sheer loss of blood, as in Werlhof's disease, the indication for treatment is plain, but the result is disappointing. Calcium chloride, ergot or ergotin, sulphuric acid, acetate of lead, or turpentine may be tried, with but little result. In the febrile form little can be done beyond combating the cardiac weakness by means of stimulants, strychnia, and inhalation of oxygen, while attempts must be made to check any necrotic tendency in the mouth. Neither large doses of quinine nor injection of anti-streptococcic serum have any influence upon the temperature, and all drugs such as calcium chloride and arsenic are apparently valueless.

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Pustule, Malignant. *See* Malignant Pustule.

Pyæmia.—The terms sapræmia, septicæmia, and pyæmia have been applied to various degrees of severity of blood poisoning. By sapræmia is meant the *presence in the blood of a soluble toxic substance* absorbed from a focus of disease on one of the free surfaces of the body, this disease being induced by pathogenic bacteria. Septicæmia means the presence in the blood not only of these toxic substances, but *the presence in that fluid of the bacteria themselves;* only rarely can the presence of these bacteria in the blood be satisfactorily demonstrated. In pyæmia we have a further grade of severity, in *the tendency to secondary infections of different organs and tissues*—the bacteria passing out from the circulation into the tissues, forming local abscesses at the site of deposit. The pathological appearances induced by these various degrees of infection do not call for description here, other than to say, that every grade of severity is met with, from the simple cloudy swelling and analogous changes in the special tissues to severe suppuration in the organs, serous membranes, and other tissues. Clinically these infections may be acute or chronic. As a rule, the more severe types of septicæmia and pyæmia are associated with some definite breach of surface on the skin, or one of the mucous surfaces of the body. As illustrative examples we may quote septicæmia or pyæmia resulting from the occurrence of sepsis at a surgical operation, or during the management of labour. The causes of this systemic infection will be found described in various articles throughout this work, see especially, "Puerperium," "Micro-organism," "Bones, Diseases of." It must suffice to say here that in many cases it is found that these infections are frequently found to be due to the pathogenic action of such bacteria as bacillus coli communis, staphylococcus pyogenes aureus, and streptococcus pyogenes—bacteria which under normal circumstances exist in the body as saprophytes. The practical question which presents itself is therefore: What are the agencies by which the tissues, *e.g.* of the alimentary tract, skin surface, respiratory tract, etc. are protected from the injurious action of these bacteria. This question is a most important one, and receives much less attention than it merits. Its undoubted complexity should not interfere with our giving it thoughtful attention. The problems of general and of local immunity are probably the most important questions in present day medicine and surgery; these have been fully discussed in the general article on "IMMUNITY" in an earlier volume. The future will probably show that the bone marrow function calls for a much closer and more minute investigation in regard to the problems of subacute and chronic septicæmia and pyæmic condition (see also "RHEUMATISM").

Pyelitis. *See* KIDNEY.

Pylorus. *See* STOMACH.

Pyrexia. *See* TEMPERATURE.

Pyuria.

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THE appearance of pus in the urine, like the presence of blood, is a symptom of many different lesions in the urinary tract. It may emanate from any portion of the apparatus, or may gain an entrance to it from neighbouring parts. Pus appears in amounts to be appreciated by the microscope only, or it may escape in very large quantities, so as to form a considerable bulk of the evacuation. It is necessary to remark here upon the methods used in the detection of pus, and the means employed to distinguish it from other urinary deposits.

The *gross physical characters of pus* varies considerably. It may be present in an acid urine in small quantity when it deposits as a slight cloud at the bottom of the test glass; it may be mixed with mucus and elude detection except by the microscope; when abundant and in an alkaline urine it may form a copious yellowish white creamy sediment, or it may be curdy and contain flakes. The appearance of pus is only a sign. It is not the physical properties of the pus that is of importance, but rather the bacteriological conditions which are associated with its presence, and unfortunately the former afford no clue to the latter. Besides detecting the presence of pus in the urine the clinical observer must determine the micro-organisms giving rise to the formation of the discharge. By the microscope alone the presence of bacteria may be demonstrated, but in order to reveal their identity cultivations are necessary, and perhaps these methods may require to be supplemented by inoculation experiments upon animals. The detection of pus in the urine is seldom of itself sufficient to guide the surgeon to a conclusive diagnosis, although by it alone information may be obtained to assist him considerably in his inquiry. But when the special characters of the pus are studied in conjunction with the circumstance attending its escape, and in view of the general features of the case, little difficulty will be experienced in discovering the nature and position of the morbid lesion.

Examination of the Urine.—The appearance imparted by the addition of pus varies according to the quantity present, and the character of the other morbid constituents in the urine.

In cases where the pyuria is due to septic lesions of the kidney only, the pus appears as a thick, opaque, creamy sediment, which on standing is rapidly and almost completely precipitated from an acid urine, the supernatant fluid is comparatively clear, is free from mucus, and does not decompose rapidly. On the other hand, where the pus is derived from the bladder alone, or in conjunction with a renal lesion, pus is not deposited quickly; when it falls it is precipitated along with glairy mucus, the urine in which it remains partly suspended is alkaline, and decomposition often begins before the urine escapes from the bladder. The time at which the pus appears in the stream should be ascertained if possible. The appearance of pus at the beginning of micturition, during the whole flow, or at the end of the act only, lends additional significance to the symptom. The precaution to ascertain the moment at which morbid constituents appear in the stream has already been referred to in connection with hæmaturia. Sir Henry Thompson, in his *Clinical Lectures on Diseases of the Urinary Organs*, 8th edition, pages 12 and 452, gives the following valuable suggestions :—"Whenever you want a specimen from your patient to examine, do not tell him to send you a bottle of it passed in the usual way, or you will get a mixture often of doubtful value. What you require is the secretion of the kidneys, plus only anything there may be in the bladder; but you also have to avoid the presence in it of any secretion which originated in the urethra. Make a point of demanding that the patient should first pass two or three tablespoonfuls through the urethra, so as to sweep out whatever may happen to be there (which may be thrown away, or be put into a separate bottle), after which you will get a pure specimen for examination—at any rate one of which you will know the source. You will have the renal secretion, plus only whatever deposit may be produced in the bladder. Suppose the patient has gleet or chronic prostatitis, there will then be a quantity of mucopurulent matter in the urethra. If all this be carried into one vessel with the urine how will you determine the different products, and decide, by the eye or by the microscope, what has come from the urethra, what from the prostate, and what from the kidneys? You cannot do it; but if you get rid of the source of error by flushing the urethra, so to speak, that is, by passing the first two or three tablespoonfuls into a wineglass, while all that follows is passed into a separate vessel, such as a tumbler, you will have in the latter a sample of urine that can be relied upon for examination.

"The necessity for avoiding admixture of urethral products with urine, in order to ensure a pure specimen, has been enjoined, and the mode of attaining the object by the use of two glasses. It is sometimes quite as essential to avoid its admixture with products of the bladder. And it is not possible to make an absolute diagnosis in some few exceptional cases without following the method in question. When, therefore, it is essential to obtain a pure specimen of the renal secretion free from the presence of vesical products, I pass a soft flexible catheter, of medium size, into the bladder, the patient standing, draw off all the urine, carefully wash out the viscus by repeated small injections of warm water, and then permit the urine to pass, as it will do, *guttatim*, into a test-tube, or other small glass vessel, for purposes of examination. The bladder ceases for a time to be a reservoir; it does not expand, but is contracted round the catheter, and the urine percolates from the ureters direct. The ureters are virtually lengthened as far as to the glass. Thus is obtained a specimen, which, for appreciating albumin, for determining reaction, and for freedom from vesical pus, and even blood, and from cell-growths of vesical origin, is of considerable value, and has sometimes furnished me with the only data previously wanting to accomplish an exact diagnosis."

The clinical significance of pyuria in many respects resembles that of hæmaturia, but differs from it in so far that an accurate diagnosis of the portion of the urinary tract from which the pus comes is more difficult to make.

DIAGNOSIS OF ORIGIN

Pus from the urethra, as in hæmaturia from the same situation, escapes independently of micturition, or is only mixed with the first few drops of urine; in fact, together with the presence of pain in the region, is usually sufficient to determine its origin. In such instances the quantity of pus is usually small and appears in flakes or threads. These are casts of ducts leading into the urethra, or threads of pus and macerated epithelium from granular patches swept away in the first portion of the stream. These urethral casts or shreds must not be mistaken for somewhat similar discharge occasionally observed in tuberculosis of the urinary tract. When urethral in origin they can be expressed from the canal before and after micturition. When the inflammation is situated in the posterior part of the urethra it may give rise to vesical irritation and some difficulty to micturition. The diagnosis can generally be cleared up by pressure upon the urethra in the perineum or rectum towards the end of micturition when pus is found to exude.

It is otherwise in *catarrh of the bladder,* in which case the pus only escapes mixed with the urine, is more or less abundant, and is accompanied by a number of large vesical epithelial cells. Vesical catarrh is generally associated with considerable pain on micturition and inability to retain urine for any length of time. A small quantity of pus in an acid urine is not necessarily of much significance, as it may be due to the slight catarrh seen so frequently in uterine and ovarian disease, but it may also be one of the earlier symptoms of tuberculosis. When the irritation is more severe, and especially when due to the action of micro-organisms, not only is the quantity of pus increased, but much mucus may be secreted. So long, however, as decomposition does not occur, the pus and mucus separate as distinct deposits on standing, but if the urine becomes alkaline before evacuation the pus becomes thick and glairy, and remains suspended along with the mucus. To establish the fact that there is cystitis is not sufficient, the cause of the altered condition must be determined, and this may be done by a cystoscopic examination.

If it has been ascertained that there is no primary urethral lesion, and no disease of the bladder, neither inflammation nor suppuration of the prostate, no pelvic or other abscesses opening into the urinary tract, then we must proceed to inquire whether the pus is proceeding from one or from both ureters. This may be done by inspecting the bladder with the cystoscope or by catheterising the ureters.

Having discovered that pus is flowing with the urine from the ureters, the next point to clear up is the nature of the renal lesion. The most important diseases of the kidney which are characterised by pyuria are pyelitis, pyonephrosis, with or without calculus, suppurative nephritis, tubercular disease, and cystic disease when the cyst has suppurated.

The question may now be asked:—Is there, by observing the urine, any means of distinguishing one form of renal pyuria from another? To some extent the microscopical appearance of the corpuscles may serve as a guide. When the pus-cells are round, well-developed, the contents of the corpuscles clear, and on addition of acetic acid show well-marked nuclei, the presumption is that they are of recent origin and have formed on a mucous surface. But if the cells contain a considerable quantity of finely granular particles, which impart a cloudy appearance to the protoplasm, if the cell-wall be irregular and ill-defined, and the nuclei few in number and small in size, the suppuration is probably deep-seated, and due to chronic inflammation.

When pyuria is a consequence of *inflammation* of the *pelvis* and *calices of the kidney,* being mixed with an acid urine, the pus on standing usually precipitates rapidly, separates clearly from the supernatant fluid, and if the inflammation be very acute, or if a calculus be present, the pus may occasionally be mixed with blood. A careful record must be kept not only of the relative, but also of the absolute quantity of pus, as sudden and marked variation in the amount is one of the most certain indications of partial or complete obstruction of the ureter from which the pus is flowing. If the disappearance of pus from the urine be associated with increase in the lumbar swelling, then followed by the sudden escape of a large quantity of purulent urine, coincident with a subsidence of the swelling, then it is clear that the ureter has been blocked for a time and its patency restored.

As the result of *calculous pyelitis,* prior to the appearance of pus, the urine is usually observed to contain an abundant quantity of mucus, which forms a bulky, tenacious mass. So long as the urine remains acid the mucus is readily deposited from the urine. This is especially the case when the calculus is composed of oxalate of lime. Before pyuria is observed microscopic examination of the deposit may demonstrate the presence of large spheroidal granular cells, degenerated epithelium, and a few blood corpuscles. When the pyelitis, which in the early stage is simply the result of mechanical irritation, has existed for some time, the quantity of pus increases and the mucus disappears. So long as the urine remains acid and no vesical disturbance arises, micturition is not unduly frequent, and the urine has not an offensive odour. But if there be frequent or considerable accumulations in the pelvis of the kidney as a result of obstruction, the fluid so retained is liable to septic infection, and if the organisms have the property of decomposing urea, the urine rapidly becomes alkaline and glairy, has an offensive odour, and is in almost all respects similar to the urine in cystitis.

When *suppurative nephritis* arises as a complication of the retention of decomposing urine, or as a sequence to a chronic pyelitis, the course of the disease is usually very rapid, and the diagnosis is not difficult. The history of some obstruction to the flow of urine is usually found, whether it be from stricture of the urethra, enlarged prostate, atony of the bladder, vesical calculus, tumours of the bladder, tuberculosis, disease of the spine, or other cause by which the bladder is kept in a distended state, and its contents rendered liable to decomposition.

When decomposition of urine in the pelvis of the kidney occurs, pyelonephritis soon manifests itself, sometimes, but not usually, by severe pain in the loins, aggravated by pressure upon the abdominal walls over the kidney. Although pain in the renal region is rare, the patient suffers from spasm at the neck of the bladder, and pain along the tract of the ureter.

The urine does not present any characters of diagnostic value as regards the situation of the lesion, and varies much according to the individual case. When the inflammation primarily involves the pelvis, and has spread rapidly from it to the kidney tissue, the urine, although purulent, remains acid for some time, and is less abundant than normal. The urine may, however, present the characters indicative of chronic Bright's disease, namely, polyuria and albuminuria, with diminution in the quantity of urea and the presence of tube casts.

Pyelonephritis is usually the result of an unhealthy state of the bladder. Consequently in that disease the urine, although it may be acid when it escapes from the ureter, becoming mixed with the contents of the bladder decomposes, is passed alkaline, has an offensive odour, and contains a large quantity of mucus, epithelium, pus, and triple phosphates. When there are no acute or chronic organic changes in the kidney, the quantity of albumin is regulated by the amount of pus or blood; but, as not infrequently chronic Bright's disease also exists, there is an albuminuria independent of these constituents, so that no proportionate relationship exists between the amount of pus or blood and the quantity of albumin.

The diagnosis of pyelonephritis from suppurative nephritis must rest largely upon a careful consideration of the etiological facts of the case. The constitutional symptoms of the two diseases are practically the same. In the former, however, pyuria precedes, in the latter it succeeds the other symptoms. If the abscess in the kidney ruptures externally, or forms a perinephritic abscess throughout the course of the case, pus may not appear in the urine; but should the abscess attain a considerable size, and rupture into the pelvis, ureter, or bladder, the sudden appearance of a large quantity of pus in the urine may clear up the diagnosis.

In *pyonephrosis* there is evidence both of suppuration and of obstruction. In some cases suppuration precedes the obstruction, in others the opposite sequence of events occurs, as when a hydronephrosis becomes inflamed, while in a third class the two conditions develop *pari passu.*

In pyonephrosis there is a characteristic renal swelling, elastic, fluctuant, and varying in size from time to time, much in the same way as in hydronephrosis. Together with these symptoms there is a discharge of pus in the urine, or evidence of its retention, manifested by increase in the renal swelling, and more severe pain in the lumbar region, which is aggravated by pressure in front, but relieved by pressure from behind. There may be also symptoms of a more urgent nature, indicative of systemic poisoning, either from non-elimination of the urinary constituents, or from absorption of infective material.

In pyonephrosis the quantity of pus in the urine varies from day to day, according to the posture the patient occupies and to the nature of the obstruction. The changes in the condition of the urine are determined by the same circumstances as those noticed in cases of pyelitis and pyelonephritis.

In *cystic disease* the urine has the characters of chronic interstitial nephritis; it is pale, copious, of low specific gravity, and may contain coarse granular tube casts. There may be copious hæmaturia, and should the cysts suppurate or pyelitis be established, pus may escape through the bladder, and in hydatid cysts of the kidney echinococci or hooklets may appear in the urine.

In tubercular disease the urine furnishes important information, and in all cases the urine should be carefully examined prior to the employment of instruments to explore the bladder or ureters. Although tuberculous bacilli are classified as non-pyogenic, and properly so, in many cases of tuberculous disease before mixed infection has occurred large numbers of leucocytes not distinguishable by the microscope from pus may be found. In pure tuberculous disease the urine is acid and free from pyogenic microbes. For diagnostic purposes it is therefore necessary to draw off through a sterilised catheter a quantity of urine and to make cultures. The presence of pyogenic micro-organisms does not exclude the possibility of the disease being tuberculous, but their absence greatly strengthens the presumption.

As the disease advances the odour of the urine as a rule becomes more and more offensive; the fluid deposits large quantities of mucus and triple phosphates, and on examination it is found to be highly albuminous. Occasionally while the urine is pale and of low specific gravity, there may be evidence of retention on the diseased side, as shown by increase in the renal swelling, with perhaps indistinct fluctuation and pain, accompanied by general constitutional disturbance, or there may be complete suppression, death being ushered in by uræmic symptoms.

In addition to the diagnostic points already indicated, the detection of the tubercle bacillus in the urinary debris is of great value. It is when tuberculous lesions begin to break down that tubercle bacilli are most abundant, and sometimes their number is very large. Several examinations are required before it can be concluded from negative results that the case is not tuberculous.

Besides the detection of the tubercle bacillus it is necessary to determine whether the disease is on one or on both sides. Several times the writer has had occasion to examine by ureteral catheterisation cases of tuberculous pyelitis, in which it was considered of importance to determine the extent to which the disease had involved one or both kidneys. Catheterisation can only determine the organ to which the tuberculous disease is limited; it cannot indicate the extent of the tuberculous lesion in the affected organ, but to make sure that one kidney is free from disease is a point of importance. The first time he succeeded in doing this was in 1886, when a case was examined, in which it was clearly shown that the tuberculous lesion was limited to one kidney.

Quarantine.—The word is derived from the forty days which formerly was the period during which persons were detained when coming from an infected country.

The system was originally introduced with the idea of protecting a country from the danger of importation of disease, a danger which is practically in direct proportion to the extent of its trade. Regulations for this purpose are sanctioned in principle by international law, which, recognising the necessity for the constant interchange of goods and commodities between various states, allows each one to protect itself in any way it may deem fit or expedient. Thus, whatever restrictions any one state may adopt, these must be submitted to by all others, as the only conditions under which trade with such state is possible.

Hence the extreme importance of the subject from a commercial point of view. The history of quarantine in this country is that of a long and fierce struggle between the two great interests of free-trade intercourse and the necessity of guarding against the risk of introducing disease arising from such intercourse.

The earliest mention of any system of defence against infectious disease is found in the marvellous and complete sanitary code promulgated by the ancient Jewish lawgiver Moses under divine guidance.

In early days the period of detention considered necessary for safety was a purely arbitrary one, but as medical science developed, an attempt was made to limit its duration to some extent in proportion to the length of the incubation period of the disease against which it was directed.

The essential point of quarantine from its earliest inception up to its modern development was to estimate the danger (and, therefore, the precautions to be taken) according to the state of health of the port from which a vessel had arrived, without any reference to the condition of the vessel and its inhabitants as regards health and sickness.

The earliest definite codes of quarantine directed against plague were issued by the Eastern emperors during the sixth century, while probably the most elaborate system of marine quarantine was established by the Venetians in the twelfth century, when they obtained sanction from the Pope to trade with the infidels of Alexandria and Aleppo. According to this code, all merchants and others coming from the Levant were compelled to remain in the house of St. Lazarus for forty days before entering the city.

In this country the first mention of marine quarantine was in 1636, when the Royal College of Physicians, in "Directions" issued by them, enacted that "care be taken that neither man nor goods may come from any suspected places without a certificate of health, or else either to be sent suddenly away or to be put to the pest-house for forty days according to the custom of Italy."

The first Quarantine Act in England was passed in the ninth year of Queen Anne. Up to that time all quarantine regulations had been issued by Orders in Council without the intervention of Parliament. But the quarantine regulations were never constant, and from their uncertainty and the increasing changes in connection with their enforcement, continually became more and more burdensome to trade.

A report of a select committee on the foreign trade of the country in 1824, mentions that the quarantine charges in the case of a vessel with a clean bill of health amounted to 7s. 6d. per ton, and in the case of a foul bill to 15s. per ton, 1s. extra being paid in London. These charges, moreover, were levied on the gross tonnage of the vessel whether she carried a full cargo or no, one instance being given in which they exceeded 90 per cent of the value of the cargo, although there had been no sickness on board the vessel.

The last Quarantine Act was that of 1824, which placed the whole system in the hands of the Privy Council, and though subsequently the actual working was carried out by Her Majesty's Customs, it remained in their hands till its final abolition by the Public Health Amendment Act, 1896.

But for a long period it had been in abeyance, remaining only on the statute book in order to avoid interference with our shipping by foreign powers. While nominally the power was in the hands of the Privy Council, who had no machinery for the purpose, the actual work of protection of the country against infection from abroad was under the control of the port sanitary authorities and their medical officers.

Port sanitary authorities were first constituted by the Public Health Act of 1872, and their powers have been slowly but gradually extended. In 1893, at the International Sanitary Congress, when Great Britain was so ably represented by the late Sir Richard Thorne Thorne, the question advanced one great step.

To his able advocacy of medical inspection as a substitute for quarantine, involving as it does the consideration of the health of the crew of a vessel, and the sanitary condition of the vessel itself, rather than the health of the port from whence she has come, this conference in a great measure owed its successful results.

All the great European Powers finally agreed to the convention. The main points were, that in the case of "infected" vessels the sick were to be removed to hospital, the healthy landed for observation for a period not exceeding five days, and the vessel disinfected. "Suspected" vessels were to be subject to medical inspection, and disinfection of such articles as considered necessary; drinking water to be changed, and the bilges disinfected. "Healthy" vessels were to be admitted to free "pratique" whatever the nature of their bills of health.

An "infected vessel" was defined as one on which a case had occurred within seven days of arrival, while a "suspected" vessel was one on which cases had occurred on the voyage, but not within seven days.

Sir Richard Thorne Thorne, agreeing to the above on behalf of this country, expressly stipulated that observation should not necessarily imply detention, but that this would be covered by registration and notification of the addresses of all persons on board such vessels.

In 1896 the Public Health Amendment Act finally abolished quarantine, and placed the whole system of medical inspection in the hands of port sanitary authorities under the control of the Local Government Board. A Local Government Board order soon followed, defining the powers of port sanitary authorities and regulating their procedure. This order, though modified in several details, still practically governs the system. It defines an "infected" vessel as one on which cholera, yellow fever, or plague has occurred during the voyage or during the stay of a vessel in the port of departure, or in a port on the course of such voyage.

The officer of customs who visits the vessel, if he has any reason to suspect the vessel to be so infected, has power to detain her, and must give notice to the Medical Officer of Health, who shall thereupon visit her. There is, however, an important section which gives power to the medical officer to visit any vessel for the purpose of ascertaining if she is infected, whether she has been visited by the customs officer or not. Under this section the Medical Officer of Health can visit every vessel coming from an infected port.

The only satisfactory method of working this system is in conjunction with the customs officer at the appointed boarding station.

In this way all the necessary precautions for the protection of the public health can be taken without hampering commerce by requiring an incoming vessel to be detained for two separate visits. This means, if properly worked, that a Medical Officer of Health must be always on duty, and accompany the customs officers on their visit for fiscal and statistical purposes. In the port of London this is carried out by having a special staff of boarding medical officers who are on duty in turn for twenty-four hours every third day.

Whether on his own initiative or informed by the customs officer, the medical officer visits a suspected vessel and examines it. If he finds the vessel to be infected, he serves a certificate to that effect on the master, who thereupon must moor his vessel in such place as required, and must carry out the instructions of the medical officer. No person may leave the vessel till he has been medically examined; those found to be suffering from cholera, yellow fever, or plague, are removed to hospital under the control of the medical officer, any suspected cases being detained for any period not exceeding two days for the purposes of diagnosis.

All those found healthy are required to furnish their names and addresses at their intended places of destination, and are then allowed to leave. These names and addresses are forwarded to the sanitary authorities of the places of destination concerned, and thus afford each authority an opportunity of keeping itself informed as to the health of such persons for so long a period as may be considered advisable.

By the terms of the order, the vessel and all effects are disinfected by the master of the vessel in accordance with the instructions of the medical officer, though in practice the disinfection is at once carried out by the officers of the sanitary authority.

There are also special powers to deal with immigrants and persons of this class who are in a filthy or otherwise unwholesome condition, or where there is some doubt as to their places of destination. Bilge water can be pumped out, and the supply of drinking water changed.

In actual practice the port medical officer keeps a register of ports which he considers as "infected." This list is revised from time to time from various official and unofficial sources. There is scope for much discretion in adding the names of ports to such list. It frequently happens that a newspaper paragraph gives the first warning of cases of disease in a foreign port. Often such rumour is followed by an official denial, and the fact is only admitted when it is impossible any longer to conceal it.

This list is a confidential one for the use of the authority only, and should never be published. It, therefore, can in no way damage the interests of any port or its trade if its name be added thereto, while its inclusion may be a most valuable protective precaution.

The instructions to the boarding medical officers should be:—

(i.) To visit every vessel arriving from "foreign" ports, and to examine every case of sickness reported, and all the crew when any suspicion exists.

(ii.) In the cases of all vessels from ports mentioned on—

(*a*) The "infected" list, to board and medically examine every person on board, checking the number by means of the crew and passenger lists.

(*b*) To obtain from the master (or surgeon if one is carried) all records of sickness during the voyage, and examine the log-book as to entries relating thereto.

(*c*) To obtain an accurate list of all the names of those on board, their places of destination, and addresses at such places of destination.

(*d*) To forward notification of such names and addresses to the sanitary authorities concerned.

(iii.) Where vessels are found to be "infected" as a result of such medical inspection, to serve a certificate on the master to this effect, and proceed to carry out the terms of the Local Government Board, reporting all the details to the Board.

Such a system appears to combine the maximum of protection with the minimum of interference with trade, and it is found in practice that shipowners will do their utmost to assist the sanitary authority, so long as they feel that their interests are studied as far as possible, with due regard to the protection of the public health.

One other point should be insisted upon, viz. the production of a "medical history" of the voyage, giving all facts connected with the health of those on board, and enumerating all cases of sickness, however trivial. Where a surgeon is carried this is a most valuable help and assistance, and where one has to rely upon a master it will often suggest what might be otherwise overlooked. From such a one facts only are required, and not opinions, for it is obviously absurd to expect to obtain a diagnosis of disease from any but a medical man.

Many of our leading shipowners have already adopted this system, and good results have been obtained, but it seems most desirable that it should be made compulsory on all.

Such a system as this involves considerable expenditure, but it should be looked upon as a system of insurance, and, therefore, regarded as a wise and prudent outlay. The question of dealing with cholera, yellow fever, and plague, must be regarded as rather a commercial than a medical one, when one considers the enormous loss to a country which ensues from the paralysis of trade which invariably follows any outbreak of these dreaded diseases. While small-pox may destroy thousands and disfigure tens of thousands without any appreciable loss to a country, the occurrence of only a dozen cases of plague may inflict a loss of millions of pounds to the trading community.

Quinsy. *See* Tonsils.

Rabies.

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Syn.—Hydrophobia.

Rabies is a virulent disease transmissible by inoculation, and contracted by man from the bite of a mad animal.

History.—Although rabies is without doubt a disease of ancient times, it was not recognised by the physicians of olden days. Aristotle writes about the rabies of dogs, but he firmly believed man to be exempt from it. The Alexandrian doctors were the first to record reliable facts about human rabies.

During the Middle Ages, and indeed until the close of last century, rabies was regarded as a mysterious neurosis, the most astounding hypotheses being formulated as to its nature; only one true fact was admitted, namely, the transmission of rabies to man by the bite of an animal.

In the last century the experiments of Majendie, Breschet, Renault, Hertwig, Benley, etc., clearly demonstrate the condition and development of this scourge. Our present more accurate knowledge of the pathology of this disease, and the solutions of the problems of prophylaxis and vaccination, as already practised by Galtier on *animals,* is mainly due to the exertions of Pasteur and his pupils, who have been equally successful in the cure of *man.*

Etiology.—Rabies is found in every quarter of the globe, in both hot and cold regions. In Europe the disease is most prevalent in France, Belgium, and Russia.

In France, during the year 1892, there were no fewer than 2169 rabic dogs. In the department of the Seine the malady is practically endemic. In Belgium during the same year there were 83 cases of rabies in dogs; in Germany the cases were much fewer, only 387 being reported in 1892; while England enjoys a still greater immunity, statistics proving 79 cases in 1891, and only 38 in 1892. From year to year, of course, the number of cases varies—an increase of rabies invariably following any relaxing of the vigilance of the police in enforcing sanitary regulations.

The influence of the seasons is not nearly so important as was formerly believed to be the case.

Rabies sometimes manifests itself in an epizoötic form; such was the case at Peron in 1803, where the ravages caused by rabies are to this day mentioned with horror.

Some countries, for example Australia, enjoy almost complete immunity from rabies,—thanks, no doubt, to the vigilant inspection of vessels on arrival at ports. Other islands hitherto immune have suffered from the pest, owing to the admission of ownerless dogs; for example, Mauritius in 1813, Malta in 1847, and Madeira in 1892.

Rabies in man being always contracted from animals, the etiology of the condition in animals must therefore first be considered.

All mammalia are liable to rabies, the different species differing in regard to degree, frequency, and severity. Domestic animals, on account of the life they lead, are most susceptible; rabies appears most frequently in dogs, cats more rarely suffer. Among the wild carnivora the wolf is frequently attacked, also the fox, hyena, and jackal. Oxen are the most susceptible of the herbivora; next in order come sheep, goats, and horses. Rabies in pigs is not so common. It is doubtful whether birds can be attacked by rabies.

In all the different animal species males suffer from rabies more frequently than females. Le Blance makes the proportion fourteen to one in the canine races.

It is now comparatively easy to estimate the extent of rabies in man, thanks to the accurate statistics of the Pasteur Institute. In France, from 1800 to 1900 individuals are yearly bitten by animals and undergo the Pasteur treatment. One thousand, at least, have been bitten by certified rabic dogs. The greater number of the cases of bites from rabic dogs occur in the department of the Seine, where there are at least forty-seven individuals bitten to each 100,000 of the population.

Men, as a rule, are more frequently and severely bitten than women; children do not suffer so often as adults. These facts are due probably to the different modes of life, clothing, etc.

The bites of rabic animals only communicate rabies in about a third of the cases in animals, and the same may probably hold good as regards man. As it is impossible to reckon all bites, this is difficult to state quite accurately; the proportion, roughly speaking, may be taken as sixteen to nineteen cases of rabies against 100 bites.

All bites are not equally venomous. Wolf bites more frequently communicate rabies than dog bites, not because the poison is more virulent in the wolf, but because he bites deeper and more than once. The bites of herbivorous animals are not deep—they tear rather than bite—and are therefore less serious.

Bites on exposed flesh are naturally most serious. If the clothes intervene the saliva may be partially wiped off the teeth in passing through to the flesh. Bites on the face are the most fatal, the mortality is 88 per 100; on the hands, 67 per 100; and on the lower limbs, 21 per 100. The vehicle for the virus is the animal's saliva, and the teeth carry it into the flesh. The saliva merely spread on the surface of the skin does not cause rabies unless there is a scratch or wound.

The theories of contagion in the air, or by the perspiration, or by the spermatic fluid, are not credited now; even infection by the blood of rabic animals is doubted, as is also infection through administration of milk or meat.

Symptoms.—I. *Period of Incubation.*—The period of incubation, running from the moment of the bite till the appearance of the known symptoms of rabies, is very variable. The ancients considered incubation to last about forty days. Recent statistics of Brouardel, Proust, Bauer, and Meintrier, allow approximately two months after inoculation, sometimes three months, and in very rare cases six months.

The extreme limit is difficult to fix. Bouley has seen cases of incubation lasting only seven days. De Beurmenn Valentin had cases running on from sixteen to eighteen months. Chantemem knew a case of a patient who had been treated with preventive vaccine, where the incubation lasted twenty-seven months. Certain conditions tend to alter the periods of incubation. It is shorter if there are many bites, and if the face is bitten probably forty-eight days instead of sixty-nine days. Incubation is generally shorter in the case of children, owing to their faces very often being bitten ; fifty-seven days is the average under twenty years of age, and sixty-eight days above that age.

All excesses, over-eating or drinking, are said to hasten the attacks, but this is a doubtful assertion. All doctors agree in trying to discover during this period of incubation *premonitory symptoms* of the approaching rabies. Some have thought that the scar has a special aspect, it cicatrises slowly, and the wound remains swollen.

An early theory was that a little worm grew under the tongues of dogs, and this brought on rabies. At a later period doctors thought they discovered under the tongue of the bitten person certain vesicles or lesions which were an undoubted test of rabies. Needless to say, such theories have no foundation in fact.

The only symptoms worthy of notice are functional symptoms which often appear, such as formication, pains starting from the wound and rising to the head and heart, cold shiverings of the wounded limb, with anæsthesia and hyperæsthesia, local paralysis, fibrillary tremors, etc.

When it is known that the hydrophobic virus is pursuing its course through the nerves these phenomena are accounted for, and the patient should then undergo very rigorous treatment.

II. *Prodromic Period.*—The prodromic period is characterised by mental and bulbar disorders. A psychic depression comes on with extreme melancholia. The patient seeks to be alone, and is haunted by fear of the dreaded malady, and disturbed by nightmares and insomnia. He suffers from general debility, and shuns his ordinary routine of life; cephalalgia and neuralgia in the seat of the wound are sometimes present. Many persons declare they see apparitions that urge them to commit suicide. During this phase there is no excitement or extraordinary quickening of the senses, or desire for inordinate movement. Later, the breathing is disturbed and incessantly interrupted by deep sighs, which contract the diaphragm to its utmost limit; the other respiratory muscles come into play, and the sufferer experiences a sensation of præcordial agony and thoracic constriction or spasm; the shoulders are pushed up. The duration of the phase is difficult to determine, sometimes it may last only two or three days, sometimes several weeks, especially if there has been a complication of nervous disorders at the period of incubation.

III. *Period of Excitement or Hydrophobia.*—This period is characterised by excessive irritability throughout the whole nervous system, specially the region of the medulla. Exaggeration of the reflexes explains the occurrence of the spasms, the most characteristic of all being the *hydrophobic spasm.*

The breathing is interrupted by heavy sighs and spasms as if one had suddenly been plunged into a cold bath. Cardiac oppression and dyspnœa develop rapidly. Spasms in the pharynx and larynx cause special difficulty in deglutition and are the true hydrophobia. When the patient desires to drink, the moment he raises the glass to his lips his face is convulsed, his eyes fixed, his body trembles, and it is impossible for him to swallow one drop of liquid. After resting a little, being still tormented with thirst, he again tries to drink; the same phenomena recur, and he cannot quench his thirst. The mere sight of water or sound of liquid poured into a glass, the mere thinking of it, or even trying to swallow solids, brings on the spasms. Occasionally certain things are tolerated, such as lumps of ice, and possibly the sufferer may be able to drink in the dark. All the reflexes of the skin, tendons, and oculo-pupillaries are exaggerated; the trembling of the muscles excites myodemia.

Any afferent stimulant, *i.e.* a sound, a breath of air, etc., on the surface of the skin induces convulsions and spasmodic breathing. The eyes are wildly bright, the pupils from time to time either abnormally dilated or contracted. Bright light seems to rouse the patient to paroxysms of fury; he shuns it, and seeks to hide in the dark.

The senses of hearing and smell are abnormally quickened, some smells bring on acute spasms, and the patient suffers from hallucinations of sight and hearing. These convulsions increase in frequency and intensity, and develop the real hydrophobic spasm. At times the spasms are convulsive; at times acute mania is developed. The precardiac agitation increases; the patient appears on the point of suffocation; his body quivers with shocks, as in an epileptic fit, or becomes rigid, as in tetanus. The attacks may at first be short and at intervals; they gradually increase in duration and frequency, lasting from fifteen to twenty minutes. The patient is frequently attacked by frenzies of passion; he screams and flings himself about, biting and tearing the bedclothes, and knocking himself against the wall. The voice becomes hoarse and he utters a barking sound, the eyes roll, the saliva dribbles from the mouth; his aspect is most alarming. In spite of these paroxysms the unhappy sufferer vainly tries to avoid biting those near him, he dreads hurting any one.

Consciousness returns during the intervals between the attacks, and the patient is overwhelmed with intense grief and melancholy, which presents a striking contrast to his former mad fury. He rarely sleeps, starts up dreaming, the mouth hangs open, the saliva cannot be swallowed; fearing to injure his attendants, the patient begs them to put him out of his misery and end his life. The face and limbs are bathed in sweat, there is obstinate constipation, often vomiting of bile and blood. The urine is seldom passed, and is found to contain sugar and albumin. Samson and Chippingdale have observed hæmoglobinuria and aglobulia. Genital disorders frequently supervene; the sufferer has emissions accompanied with great pain, and forcing cries of agony.

Fever increases as the prodromatic phase progresses; it abates slightly in the mornings. As death approaches the temperature rises very high, as much as 43°. Even after death it may still continue high.

The pulse is rapid and intermittent.

Death may result from asphyxia during the course of such an attack.

The period of excitement may last one or two days; death invariably results from asphyxia or syncope.

IV. *Paralytic Period.*—This period only lasts a few hours. The sufferer loses all consciousness and falls into a state of collapse. In very rare cases consciousness may return at the point of death.

FORMS.—The ordinary form of rabies is characterised by a complete disorganisation of the whole nervous system. More rarely the furious and preliminary stages are absent and the rabies is manifested by paralysis from the outset; the paralysis appears, accompanied with acute local pains, mental depression, and other sensory troubles. The sufferer moves the bitten limb with difficulty, there is paresis with loss of co-ordination present; and later the paralysis becomes total. At first limited to a monoplegia or paraplegia, it extends, accompanied by severe pain, to other regions of the body; tongue, face, eyes, bladder, rectum, and intestinal muscles are all paralysed, and there is constipation and retention of urine. Lastly, though not invariably, the vital centres in the medulla are affected, breathing disorders set in, and with them true hydrophobia. The paralysis usually commences in the bitten limb; occasionally it may begin in the opposite side. The paralysis comes on at a late stage after the usual symptoms have set in.

Finally, where subjects have been inoculated with Pasteur's vaccine rabies appears in a more modified degree, limited to the prodromic phenomena, as observed by Chautemann, Roux, and Laveran. Rabies does not seem to depend on the kind of bite. Gamaleia contends, however, that the worst bites bring on paralytic rabies; on the other hand, Di Vestea and Zagari maintain that ordinary rabies results from bites on the head, and paralytic rabies or "dumb rabies" from bites on the lower limbs.

Animal Rabies.—All the animal species suffer from the two forms of human rabies, namely, hydrophobia and dumb rabies.

With dogs furious rabies is the most common, and exhibits itself in much the same way as in the human race. Depression, depraved appetite, hallucinations, fear of water, changed bark, dysphagia without hydrophobia, and fever. Presently the animal is seized with a frenzied restlessness, a determination to bite any thing or person he meets. Death follows paralytic collapse.

Dumb rabies is exhibited by a slow paralysis which first centres in the muscles of the jaw. Death results in three or four days.

PROGRESS—DURATION—TERMINATION—PROGNOSIS.—The course taken by rabies is progressive, rapid, and fatal. The bulbar phenomena precede the cortical phenomena; the rabic virus mainly attacks the nerve centres.

The duration is difficult to determine on account of variability in the prodromic period; but from the first symptoms to the development of true hydrophobia the course is rapid, and death takes place in three or four days, in some cases even on the first day. Paralysis is slower, though not less fatal, death ensuing on the seventh or eighth day.

Rabies is almost always fatal, and death is due to asphyxia or syncope. Death may also result from traumatism or suicide during the frenzied period. Veterinary surgeons have recorded cases of recovery from rabies in animals; possibly these were mild cases of slight inoculation on an anterior part (Hagges). Laveran, Roux, and Chantemesse have recorded cases of rabies being cured when the patient underwent treatment at the Pasteur Institute. Novi and Poppi knew a case of a patient suffering from rabies, who by the twentieth day of the curative treatment was almost cured. It is thus evident that rabies is not necessarily absolutely fatal.

Diagnosis.—The diagnosis of human rabies as a rule is simple, though there are certain diseases which may simulate rabies.

The imaginary hydrophobia of a bitten person is excited by suggestion in a neurotic subject. If the patient has some knowledge of the symptoms of human rabies the diagnosis may be difficult. The patient may also imitate canine rabies. If it can be proved that the suspected dog was not mad, it may be well to assume, in the absence of a period of incubation, that the symptoms are merely hysterical stigmata, simulating rabies.

Tetanus has a much shorter period of incubation, is always accompanied by contractions, especially a persistent trismus, but it never develops into real hydrophobia.

Certain *poisons*, such as stramonium and belladonna, exhibit some symptoms akin to rabies.

In *delirium tremens*, hallucinations and delirium usher in the attack, whereas in rabies, spasms and respiratory disorders predominate from the outset.

Paralytic rabies is a form of acute paralysis, whose etiology is the only guide to its correct diagnosis.

It is generally a simple matter to recognise human rabies; it is a more difficult task to foresee and determine rabies in the dog, but this is a matter of the gravest importance; and this diagnosis is absolutely necessary in order to judge of the course to be pursued in treating the bitten man or animal.

Rabies is not always easy to recognise in the living animal. It is necessary to shut up the suspected dog and keep him under vigilant observation for at least forty-eight hours. By killing the dog too soon the risk is run of not obtaining from the autopsy definite or satisfactory indications of the disease.

In cases where the presumption of rabies justifies it, the animal must be slaughtered, and a diagnosis made by a post-mortem examination. The same examination should be made by the veterinary surgeon, even if the animal has been slaughtered before he sees it.

The presence of foreign substances in the stomach and intestines, the absence of food in the alimentary canal, dryness of and accretions on the mucous membrane, the presence of glycosuria, are indications of the disease, but not conclusive ones.

The histological examination of the nerve centres furnish still more convincing proofs. Babés studied a portion of the medulla of a dog, and searched for the rabic nodules (see p. 285) formed on the nerve tissues and surrounded by areas of small cell infiltration. Their presence convinced him that the case was one of true rabies. Van Gehuchten studied the ganglion of the pneumogastric nerve, and asserted that in rabic animals there were specific alterations of the nerve cells. Piliet and Vallet admit that the lesions described by Van Gehuchten are peculiar to rabies, but they appertain to an advanced stage of the disease, and are never found in the animals slaughtered in the early stages of the disease. Marinisco considers that the nerve lesions noted by Babés and Van Gehuchten are unreliable symptoms, being neither specific nor invariable.

To obtain a correct diagnosis, we must have recourse to bacteriological proof, a portion of the medulla of the suspected animal being aseptically inoculated into the eye of several susceptible animals, such as dogs or rabbits. Unfortunately this diagnosis is a very lengthy process, satisfactory results seldom being obtained before thirty or forty days, indeed often not till the ninetieth day. Therefore persons who have been bitten should at once be sent to the Pasteur Institute without waiting for this tardy result.

PATHOLOGICAL ANATOMY.—For a long time the anatomical lesions of rabies were entirely unobserved. By degrees physicians began to describe certain vascular lesions in conjunction with small cell infiltrations of the nerve centres, and in consequence rabies was treated as an encephalic myelitis. Since 1890 histologists have observed various microscopic lesions, the exact nature of which has not yet been explained.

At the autopsy of a man or animal who has died of rabies, the cerebral and spinal meninges are invariably found to be greatly congested and œdematous, with hæmorrhages at the vein centres. The adjacent nerve tissue presents a congested appearance, with small hæmorrhagic spots. These lesions are most numerous in the region of the medulla, the basal ganglia, spinal cord, and anterior and posterior nerve roots.

Microscopical examination reveals alterations in the blood-vessels; they are surrounded by small cell infiltrations, which give them a moniliform appearance. These nodules consist of clusters of round perivascular cells. The veins appear to have undergone a hyaline degeneration (Kolesnikoff). There is also small cell infiltration and a multiplication of the fixed cells, the transparency of the veins becoming obscured by a thrombus or by the accumulation of leucocytes. The diseased veins are liable to burst. Benedict found miliary aneurysms; Schaffer and Babés observed capillary hæmorrhages. The nerve cells of the cord and the medulla undergo marked alterations. Schaffer and Poppof studied the pigmentary atrophy of the cells in two cases of human rabies. Babés, Golgi, Nagy, Marinisco, etc., describe these chromatic phenomena, changes in the colouring matter and in the protoplasmic cells, actual disappearance of the chromatic elements, vascular degeneration, loss of the cellular prolongment, and modification and disappearance of the nucleus. Babés follows up Kolesnikoff and Coats in describing the relations between the cells; tells how they are invaded by small round cells and hyaline corpuscles. He lays special stress on the pericellular miliary foci, which he styles rabic tubercles, and deems an invariable accompaniment of rabies.

Van Gehuchten and Nélis studied the lesions of the cerebro-spinal ganglia, which they in their turn consider specially characteristic of rabies. Numerous nerve cells disappear, and are replaced by clusters of small round cells. The remaining cells present various lesions of the protoplasm and nucleus; at times even the nerve cells of the ganglion entirely disappear. These lesions attain their maximum in the nodose ganglion of the pneumogastric. Polaillon and Nerven had already noticed analogous lesions in the Gasserian ganglion. The most noteworthy changes are (according to Schaffer) found in the medullary segments, which have a nerve connection with the seat of the bite. In the white substance the axis cylinders become enlarged, either denuded or contrariwise, surrounded by a thick veil of myeline. The peripheral parts of the nerve, especially the nerves of the bitten limb, undergo degeneration.

A study of the lesions of the other organs is equally interesting and characteristic. Pharyngitis, congestion of the salivary glands, gastric congestion, hepatic congestion, etc., are all noticeable. An examination of the stomach proves of use in dogs: the presence of unusual objects in the viscera, of whatever kind, is most essential in a retrospective diagnosis of rabies.

The bronchial mucous membrane and the lungs are congested, the kidneys are often the seat of nephritis. The lymphatic glands are enlarged, the blood grows diffluent and dark in colour, as it does in grave infectious fevers; hæmorrhages occur in the different organs.

BACTERIOLOGY.—*Experimental Rabies.*—The experimental study of rabies has been most exhaustively investigated by Pasteur and his students. Though it is still impossible to state definitely the precise nature of the rabic virus, their able researches have found out the seat of the virus in the organism, its mode of introduction and propagation, and the best means by which its virulent activity may be modified. This study brings us to the practical application of the Pasteur vaccine.

Seat of the Virus in the Organism.—It was long supposed that the saliva of rabic dogs and human beings was virulent, and Grunner and Salm Reiferschidt in 1813 furnished proofs of this. Novard and Roux later have proved that this is only supposition, and show that virus in the saliva is capricious and variable, and greatly depends on the point of inoculation. In the case of a dog inoculated in the eye, the saliva became virulent *three days before* the appearance of the nervous phenomena, and in a dog inoculated in the neck the virus became virulent *thirty hours before* the animal developed rabic symptoms. The virulence of the saliva does not proceed from a dilution with the bronchial mucus as P. Bert believed. The experiments of Hartwig, Galtier, and Bardach are proof that the salivary glands themselves contain the virus. Galtier, Breschet, Renault, P. Bert, etc., all agree that the virus does not exist in the blood, the lymph, or the muscular tissue. In rare cases the milk has been found to be infected (Perroncito, Carita, and Nocard). The poison also may occasionally infect the glands and various secretions of the body, *e.g.* pancreatic fluid, spermatic fluid, urine, etc.

The nervous system contains the virus with marked and unfailing certainty. It is always found in the medulla, in the spinal cord and brain. The white substance contains an equally virulent virus as the grey substance. Pasteur proved that for the purpose of inoculation the medulla, treated aseptically, may be used as a far more reliable inoculant than the saliva. The virus is also found in the peripheral nerves, but not so invariably (Roux).

Modifications of the Virus by Physical, Chemical, and Biological Agents.—In the cadaver the rabic virus has been found to resist putrefaction for forty-five to fifty days (Galtier). Its virulence progressively diminishes (Russo, Travali, and Brancaleone).

Roux recommends glycerine as the best agent in which to preserve the rabic medulla; the bulb may be kept in glycerine for four weeks without any sensible diminution of its virulence.

Heat has a powerful effect on the rabic virus, which is rapidly destroyed at 60° (Roux), in one hour at 90°, and in twenty-four hours at 49° (Celli). Cold, on the other hand, has little or no effect; the medulla of a rabic rabbit preserved its virulence for ten months kept at a temperature of 10° to 27° (Celli). The freezing of 7° to 8° atmosphere have no effect. The action of light can destroy the virus in forty hours at 37° (Celli).

Antiseptics quickly destroy the virus (Celli).

Pasteur makes use of the combined action of the air, of desiccation, and of light in diminishing the strength and ultimately destroying the virus, and also in obtaining spinal cords possessing varying degrees of virulence. The spinal cord of a rabbit exposed to a drying air at 23° loses its virulence in six days.

The activity of the rabic virus may be modified at will by its passage through several animals. The virus of dogs, whose mode of existence has already inoculated them with "the virus of the streets," is less deadly. The virus from one of them inoculated under the dura mater will give rabies after an incubation of fifty days.

An increase of the virulence is obtained by successive passages through rabbits, the inoculation each time being made from the medulla of the last rabbit. At the 133rd passage the duration of the incubation is seven days; at the 178th it is six days (Pasteur). The "virus of passage" is a "fixed virus." It retains its strength in passing through a dog, and always kills the rabbit with the same incubation period. The rabbit is thus a reactive agent on account of the purity and strength of the rabies, which in its case assumes the paralytic form, the paralysis commencing in the posterior parts, and is preceded by increased rapidity of breathing, by polyuria, a loss of weight, and rise of temperature. The "fixed virus" is more rapidly obtained by passage through young animals (Hogyis). An attenuation of virulence is obtained by passage through the monkey.

Inoculation with Virus.—All parts are not equally favourable for inoculation. The surest and most rapid entrance is inoculation in the seventh nerve ; its results never fail. Pasteur has also trephined the cranium and injected the virulent liquid under the dura mater with equal success.

The same holds good of inoculation into the subcutaneous lesser nerves, by tempering a section with one drop of virus (Di Vestea and Zagari).

Intra muscular inoculation has much the same measure of success (Helman).

Inoculation by scarification of the skin succeeds only in one-third of the cases, and has besides a very variable incubation. It is only resorted to if the virus is impure.

Inoculation of the subcutaneous cellular tissue of the serous or mucous membranes cannot be relied upon. Bardach and Nocard are very doubtful whether injections of rabic spinal cords into the mucous membranes of animals is effective. Galtier also obtained very doubtful results from painting the mucous membrane with virus, so much depends on the condition of the mucus. Inoculation into the blood results, according to circumstances, in either rabies or protective vaccination In treating dogs, an injection of rabic saliva only infects them with rabies uncertainly, whereas the injection of an emulsion of the medulla always results in rabies (Roux). With regard to ruminants Galtier asserts that venous inoculation is vaccinative, not infectant.

Intra-uterine transmission of rabies is made by the blood-vessels ; Perroncito, Carita, and Camillac and Gibier all agree as to this fact.

Mode of Propagation in the Organism.—Jaccoud had already surmised that the rabic virus is propagated through the nerves. Experiments by Di Vestea and Zagari have proved that after inoculation under the dura mater of the brain the toxines first appear in the medulla, proceeding thence to the lumbar enlargement. Again, if the sciatic nerve is inoculated, the lumbar enlargement becomes virulent before the medulla. Lastly, if the nerve is excised below the inoculated point, and the peripheric end cauterised, the infection is either abortive or checked for the time. In the same manner if, after inoculation of the sciatic nerve, the spinal cord is divided below the origin of the nerve, all the inferior segments of the cord and the nerves which have been divided become virulent, but the superior segment remains normal.

These facts have been confirmed by the experiments of Roux, who has found that only the nerves nearest the bite are virulent.

This accounts for the gravity and rapidity of the virulence when the bites are on the face, a region full of nerves, and nearer the medulla than the limbs.

As formerly mentioned, the virus may also be transmitted through the blood-vessels into the body.

Nature of the Virus.—The active agent of rabic infection is most probably a living organism. The progress of the disease, its inoculability, the resistance of the virus to physical and chemical agents, all point to microbes as the causal agent (Roux). The loss of virulence in filtered liquids, although they can be preserved and propagated by the filter, betrays the presence of microbes, although the particular microbe has not yet been isolated.

Immunisation.—In 1881 Pasteur, in the course of his researches, ascertained that certain dogs inoculated with non-fatal rabic virus were thus vaccinated against subsequent inoculations. His aim then was to procure this immunisation or vaccination by every effort in his power.

By passage of the virus a certain number of times through monkeys, Pasteur in 1884 was able to obtain a virus of diminished virulence. Progressive inoculations of this weakened virus was found to immunise dogs against the fixed virus, inoculated by trephining.

The following year Pasteur and his colleagues, Chamberland and Roux, discovered a new method of attenuating the virus by desiccation, more unfailingly certain than the other in its results; this method is still in vogue.

Subcutaneous injections of progressive virus immunise the dog against the fixed virus, even if a virulent inoculation precedes the vaccinal inoculation. These attenuated viri are obtained by suspending the rabic spinal cord of rabbits in a flask containing potash, kept in a temperature of 23°. By the sixth day the cord has lost all virulence. To prepare the cord for use, a piece 3 millimetres long is dissolved in 1 centimetre cube of sterilised bouillon.

The virus can also be attenuated by diluting an emulsion of rabic tissue in saline solution (Hogyes). Babés dilutes the cord tissue in the serum of an immunised dog. These viri are usually inoculated under the skin; Galtier also affirms that ruminants may be inoculated by the blood-vessels, but this process is not infallible. Immunity may be obtained very speedily. Thus it is possible to inoculate dogs, and in eighteen hours they can resist inoculation of the fixed virus under the dura mater. Ordinarily, immunity cannot be obtained before the tenth day.

Immunity renders the subjects capable of sustaining considerable doses of virus by inoculation. An operator has been able without difficulty to effect 209 inoculations in six months.

The immunity lasts one year in 21 cases out of 100 dogs so treated; two years, 33 per 100; five years or more with others (Pasteur).

The production of this immunised medium is not easily explained. Desiccation does not seem to act altogether as a diminisher of the virulence of the rabic marrow, for in cases where rabbits have died from inoculation with the dried marrow their medulla still contains fixed virus. Immunity is not then obtained by inoculation with attenuated virus. Possibly the attenuated virus has only an impoverishing effect on the virus contained in the cord (Hogyes).

Pasteur has a theory that the immunising agent points to the presence of an antitoxin matter associated with the rabic microbe. The microbe keeps its virulence intact in all the desiccated cords, but there destroys itself more quickly than the vaccinal matter.

Vaccination with soluble substances elaborated from the rabic microbes has also been tried unsuccessfully. Babés and Cerchez, with moderate success, have employed blood of vaccinated animals as an agent. According to Nocard the vaccinated serum destroys the rabic virus when it is in contact with it, but it does not succeed in preventing its evolution.

TREATMENT.—*Prophylactic.*—The most efficient prophylactic measures for checking the spread of rabies are sanitary regulations properly enforced. It is essential that all cases of known or suspected rabies be at once notified to the authorities, who have power to slaughter all animals suspected of having been bitten. The total destruction of all the contaminated animals is almost impossible owing to the vast number of ownerless dogs. This difficulty has been met and considerably modified in countries where there is a sufficiently high dog-tax. The Veterinary Congress at Vienna in 1869 fully recognised this. The payment of the tax would be considerably aided if all dogs were obliged to wear a tax medal. Bavaria is a striking example of vigilant police surveillance. In 1873 there were 821 cases of rabies in Bavaria; the numbers fell to 69 cases in 1881, and 6 cases in 1884. The enforcement of police regulations has banished rabies from the Grand Duchy of Baden, Holland, and Sweden.

Curative Measures—(1) *After the Bite.*—When local treatment can be immediately applied it must not be neglected, always remembering that this treatment is very insufficient, and should not inspire a false security.

Immediately after the bite the wound must be attended to, first by tying a ligature on the limb above the bitten part, and then cauterising the wound deeply with a red-hot iron. If the teeth have not penetrated beyond the sound surface of the skin it is sufficient to bathe the infected parts with an antiseptic. Inoculation is always necessary, and ought to be done as soon as possible after the bite. According to the old method the treatment lasted ten days; an inoculation was made each day, commencing with the fourteenth day's marrow, and leading on successively to the fifth. At the present time this method is extensively employed, beginning with the fourteenth day's marrow and ending with the third. In serious cases the different degrees of marrow are used more rapidly, arriving on the third day to marrow of the sixth strength, and the fourth day to virulent marrow. The duration of the treatment varies, according to the gravity of the case, from fifteen to twenty-two days. If any pain is still felt at the seat of the bite a fresh series of inoculation is begun, which frequently may check the development of rabies. The inoculations are not very painful, and are only followed by a general local reaction, sometimes by erythema and itching. In order properly to estimate the results of the inoculation treatment we must look at the statistics of the Pasteur Institute. In 1896 the number of persons treated was 1308, of whom only four died. This gives a mortality of 0·30 per 100. When this mortality is compared with the mortality of non-treated rabies, which is 16 per cent, the immense benefit of the Pasteur treatment can be better appreciated. The statistics of the Pasteur Institutes in France and other countries agree with those of Paris. Nevertheless there are many criticisms and objections made to rabic inoculation. Indeed, it is accused of being inefficient and dangerous! The foregoing statistics conclusively answer the first objection, and Vulpion and Brouardel have replied to the second. They maintain and prove that of the inoculated cases which do not recover death is due to "the rabies of the streets," not to the "rabies of the laboratories," as Peter terms it.

(2) *After the Appearance of Rabies.*—The Pasteur treatment is ineffectual after the rabies is pronounced, unless it happen that the rabies come on during the course of the treatment—then there may still be hope. Noir and Poppi have saved cases of paralytic rabies, appearing about the twentieth day of treatment, by substituting intravenous injections for the subcutaneous. Other remedies are merely palliative. Large doses of morphia, chloral, chloroform, or bromide of potassium may be administered, to soothe the paroxysms. The injection of artificial serum or continuous currents along the spine may be tried with good effect (Schivardi). Finally, it is essential to avoid all excitement, and keep the sufferer in a darkened room, avoiding light, noise, draughts, or anything likely to excite his extreme nervous susceptibility.

Rachitis. *See* RICKETS.

Railway Spine. *See* SPINE.

Ranula. *See* TONGUE.

Rape. *See* MEDICINE, FORENSIC.

Raynaud's Disease.

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Erythromelalgia

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Although instances of this disease have been recorded in medical literature as far back as Schrader's case in 1679, it was not until the year 1862 that the French physician, Maurice Raynaud, called attention to the group of symptoms which has since borne his name. Like migraine, epilepsy, and the so-called "functional" diseases, Raynaud's disease is a clinical, not a pathological entity. Whilst it forms a striking clinical picture, and is doubtless dependent on some faulty innervation of the vascular system, yet no constant structural changes have been found, either in the nervous or vascular tissues, which can adequately explain the profound morbid appearances presented by this affection.

Etiology.—*Sex.*—The disease is commoner in the female sex, the proportion (both in Munro's 180, and in Cassirer's 104 collected cases) being 1·7 females for every male. The *age* of onset, in the vast majority of cases, is under thirty years, the average of 171 cases being 28·9 years (Munro). From the striking frequency with which young adults are affected, Raynaud was inclined to apply the term "juvenile gangrene" to the affection. But no age is exempt. Infancy and old age alike have been attacked, the youngest recorded case being that of an infant aged six months (Friedel), the oldest that of a woman of seventy-seven years (Henry). A *neuropathic diathesis* seems to be the most important predisposing factor. Raynaud himself pointed out that nervous individuals are chiefly affected. Direct heredity, on the other hand, where parent and child have both suffered from the disease, is uncommon. The most frequent exciting cause is *exposure to cold and damp*, and such patients are often abnormally sensitive to cold. Thus, as might be expected, the complaint is commoner in winter than in summer, and occurs more frequently in people whose occupations entail exposure to cold and damp, *e.g.* washerwomen. Many cases, however, occur in which no such exciting cause can be found. Fatigue, especially when combined with exposure, may bring on an attack; so also may *mental shock or emotion.* There is no evidence that disorder of the sexual organs has any causal relation to the complaint. Raynaud's disease may also supervene during the course of other chronic affections such as malaria, congenital syphilis, gout, chlorosis, diabetes, and paroxysmal hæmoglobinuria. A few cases have been recorded in which a *toxic* influence appears to have been at work, as when the symptoms have developed for the first time during an attack of intestinal obstruction.

Symptoms.—*Summary.*—The chief symptoms are pains, more or less severe, and paræsthesia of various sorts. They are not confined to the area of distribution of definite nerve trunks, but affect, usually, the periphery of the limbs (more commonly the upper extremities). Less commonly they occur in other situations, such as the ears, lips, nose, etc. The distribution is generally symmetrical. To these symptoms are superadded signs of paroxysmal vaso-motor disturbance in the form of (1) *local pallor* ("*syncope*"), or (2) *local cyanosis* ("*asphyxia*"), less commonly redness. After a time, or even in some cases without antecedent vaso-motor phenomena, trophic lesions occur in the affected parts mostly of the nature of (3) *gangrene.* These three stages of the disease may occur either successively, or the first and second may occur without the third, and conversely. The course of the disease is an intermittent one. Anæsthesia and motor paralysis as a rule are absent. During the intervals between the paroxysms there may either be persistent signs of faulty vaso-motor innervation, or there may be no such signs or symptoms. The disease may exhaust itself in a single paroxysm, or many successive attacks may occur.

(1) *Local Syncope.*—In this form of Raynaud's disease the affected parts, usually the fingers (less frequently the toes, sometimes the margins of the pinnæ, the tip of the nose, or in rare cases even the tip of the tongue) suddenly become cold to the touch and white in colour. The degree of pallor varies; it may be waxy, tallowy, or corpse-like; sometimes it is bluish-white. What usually attracts the patient's attention, however, is not so much the change of colour, as some sensory disturbance in the form of pain or paræsthesia, *e.g.* numbness, tingling, feeling of stiffness, or an indescribable consciousness that something unusual is going on in the part. As the pallor increases, so does the pain or paræsthesia become more intense, and at this stage objective blunting of sensation to touch can often be recognised. Marked anæsthesia to touch may co-exist with severe subjective pain. The power of movement of the affected fingers or toes may be temporarily impaired. This is probably not a true motor palsy, but due to deficiency of afferent impressions causing clumsiness of the fingers. In exceptional cases slight secretory phenomena have been observed in the form of cold perspiration in the affected parts.

The distribution of these phenomena varies. It may be unilateral or bilateral. Sometimes it is so exactly symmetrical that the identical digits are affected in both hands. The terminal phalanx alone may be attacked, or the condition may extend upwards along two or more phalanges, or may even, in rare cases, involve the whole hand or foot. The thumb frequently escapes, the other fingers seeming to be equally liable. One or more fingers may be affected at a time.

The duration of a paroxysm may be momentary or may last for hours. Numerous attacks—twenty to thirty per diem—may occur in rapid succession, or the paroxysms come at longer intervals:—weekly, monthly, or perhaps only in winter. The return to normal after an attack also varies in different cases. In some it is sudden; in others pallor is followed by a stage of reaction with tingling, burning pains, and local heat and redness. Or the condition may pass on to the second stage—that of local cyanosis.

In its mildest form local syncope is popularly known as "dead finger," a condition not uncommon in nervous people and in otherwise healthy individuals on exposure to cold, mental excitement, etc.

In predisposed individuals the attack often comes on whilst washing the hands in the mornings, or while performing fine digital movements, such as piano-playing or sewing.

As a rule, during an attack the accessible arteries of the limb are not perceptibly altered in calibre, though occasionally the pulse may be reduced in volume. In a few cases hæmoglobin has been found free in the blood-plasma of the affected finger (local hæmoglobinæmia).

Repeated attacks tend to make the fingers thin, parchment-like, and conical — sclerodermia. In spite of numerous attacks, however, the general health is not necessarily impaired, and the condition remains a purely local one.

(2) *Local Asphyxia or Cyanosis.*—This is a stage of the disease in which there is sudden discoloration of the skin, varying in tint from a dusky blue or slate-colour to an intense purplish-black. Sometimes an admixture of red may be present. Pressure on the discoloured part causes a white mark which persists for some time, lividity returning to it with great slowness. The parts adjacent to the affected area often show a bluish mottling, which in exceptional cases spreads over the whole body.

The local temperature falls during the paroxysm to an extent corresponding to the duration of the cyanosis.

A slight degree of swelling, not œdematous nor indentible on pressure, is fairly common. If the cyanotic area be pricked, dark blood escapes, unless gangrene be about to set in, when no blood flows. The veins of the cyanotic parts are sometimes distended; in rare cases they have been seen spasmodically contracted, and Sir T. Barlow has observed a beaded appearance, rapidly shifting in position, in the veins. In a considerable number of instances the cyanosed part sweats freely, especially when it is beginning to regain its normal colour.

Local cyanosis may either develop directly from the normal, or it may follow an antecedent stage of local syncope. Pallor and cyanosis may succeed each other, and conversely, in the same patient. Or there may be pallor of the distal phalanx with cyanosis of the proximal, or *vice versâ.*

As the paroxysm of cyanosis subsides—which it may do after a period varying from a few minutes to several hours—there may either be an interval of active hyperæmia or a gradual subsidence of the lividity by the appearance in the dusky area of bright spots, gradually coalescing. Other cases, again, pass directly from the stage of cyanosis into that of gangrene.

Cases of sclerodermia from Raynaud's disease nearly always manifest at some stage the symptoms of local asphyxia.

Subjective symptoms are sometimes absent; more often, however, during a paroxysm there is pain of a burning or stinging description, which may be of agonising intensity.

Anæsthesia, analgesia, or thermanæsthesia may be present, separately or conjointly, or hyperalgesia may occur. On the other hand sensation is sometimes unaffected.

As to distribution, whilst local syncope seldom occurs except in the limbs, local cyanosis, though preferring the limbs (and the upper rather than the lower), frequently attacks the ears and face. The distal parts of the limbs, ears, and nose are most commonly affected; the cheeks, chin, and tongue less frequently. Patches of lividity on the trunk or on the proximal segment of a limb are uncommon. The order in which different parts are attacked is extremely variable, and is not always the same in successive paroxysms. As a rule the parts affected are roughly symmetrical, though unilateral paroxysms also occur.

(3) *Symmetrical Gangrene.*—In this variety of the disease trophic changes are superadded to vaso-motor phenomena, gangrene being the final stage towards which the others tend. It is usually preceded by local asphyxia, and often by local syncope also.

The parts most frequently involved are the extremities of the limbs (especially the upper limbs) and of the ears, unilaterally or bilaterally. The thumbs are less liable than the other digits. In exceptional cases gangrene attacks other parts, such as the cheeks or chin, and in rare instances the penis. Labia majora, nipples, lips, eyelids, tissues over the coccyx, or the proximal parts of the extremities, have also been affected. Instances have occurred where large areas of the limbs have been attacked.

Thus in one of Barlow's cases amputation had to be performed in the middle third of the calf.

As a rule the gangrenous process is confined to a small part of the cyanosed area. In its mildest form the necrosis may be limited to the epithelium, so that only desquamation results. More often a small blister forms, with sanguineo-serous or dark contents. This bursts, causing an excoriation or ulcer in the skin which, on healing, leaves a scar behind. The nails may be lost and subsequently reproduced. If the necrosis extends deeper into the cutis and subcutaneous tissue, large blebs form which, as the subjacent tissues necrose, become deep brown. The slough ultimately separates and leaves a slowly-healing ulcer, sometimes with sharply punched-out margins.

The soft tissues may necrose to any depth, and whole phalanges thus undergo dry mummification. A line of demarcation forms, and the gangrenous part is cast off, leaving a conical stump behind. As a rule the bones escape necrosis. The resulting scar often remains for weeks crusted with scabs, which tend to re-form on removal. Moist gangrene is rare.

Gangrene and cyanosis may be present simultaneously in the same limb, and the three stages of syncope, cyanosis, and gangrene may be observed at one time in different digits. This, however, is uncommon. The distribution is roughly symmetrical, though not necessarily equally intense on the two sides. There may be severe gangrene in the limb of one side, with an insignificant blister on the other.

Several types of cases occur: in one variety attacks of local asphyxia occur, in which the cyanosis becomes constant instead of intermittent, and in the dusky area a part necroses and is cast off. In another type paroxysms of local syncope or cyanosis occur, and small blisters, ulcers, or sloughs develop in the affected digits. In others the cyanosis is chronic from the outset, especially during the winter months, not paroxysmal, and small blebs or ulcers appear in the cyanotic area. In rare cases symmetrical gangrene has occurred without previous cyanosis.

Pain is usually a marked feature, especially during the preceding paroxysmal cyanosis. It is often of excruciating intensity, not confined to the gangrenous parts, but radiating from them up the limb. Yet in some cases cyanosis goes on to gangrene quite painlessly; this, however, is exceptional.

Progress and Complications.—Raynaud's disease usually occurs in a succession of paroxysms, the duration of each varying from a few minutes to many hours. A large number of cases never go on to gangrene, but consist merely of attacks of local syncope and local cyanosis, or of either of these alone. Some of the less acute cases, *e.g.* after acute fevers, recover permanently and completely. Some cases, even of gangrene, have only a single attack and do not recur.

Amongst the various *complications* which may occur, one of the most important is *sclerodermia* of the fingers, which may precede or succeed the Raynaud's disease, though it often occurs totally unassociated with the latter. Other diseases of the skin are also occasionally associated with Raynaud's disease, amongst which may be mentioned urticaria, cutaneous hæmorrhages, and angio-neurotic œdema. Joint effusions, with subsequent ankyloses, especially of the smaller joints, have been observed.

But complications of a less local character also occur. Thus sometimes one of the acute infective fevers has been an antecedent. Other cases give a history of *malaria*, sometimes many years before. Such cases would point to the *toxic* origin of some cases of Raynaud's disease.

Numerous urinary abnormalities have also occurred, of which the most important is *paroxysmal hæmoglobinuria.* This has been noted in over 6 per cent of cases. The connection between the two diseases is regarded by some as a very close one, so much so that they consider the two states as essentially identical; both being paroxysmal and both excited by cold. Others, however, regard hæmoglobinuria as a secondary complication, since it occurs not only in Raynaud's disease, but also in the course of other morbid conditions, such as malaria and syphilis. Malaria is certainly a fairly common antecedent of hæmoglobinuria. It is conceivable that in certain cases of local cyanosis a local hæmoglobinuria is produced (indeed, in a few cases free hæmoglobin has been demonstrated in the blood-serum obtained from the affected finger during a paroxysm), and that this causes the subsequent appearance of hæmoglobin in the urine. But in some cases hæmoglobinuria precedes the local cyanosis, or is concomitant with it, and if there be a cause common to the two symptoms it must be a central one.

Albuminuria, constant or intermittent, has been observed, the latter being rare and sometimes combined with hæmoglobinuria. Diabetes insipidus and glycosuria have been recorded in a few instances, but the possibility of diabetic gangrene should always be carefully borne in mind.

Cardio-vascular disease has been noted in fully 12 per cent of cases. Some of these are, no doubt, mere accidental coincidences. Epistaxis sometimes occurs. Syphilis, hereditary or acquired, has been noted in a few cases, in certain of which antisyphilitic treatment relieved the vasomotor symptoms.

Diseases of the nervous system are relatively common, being present in nearly one-fourth of reported cases. Hemiplegia is the commonest variety of nervous disease, but hydrocephalus, acromegaly, spinal tumour, and tabes dorsalis, or such complaints as hysteria, chorea, epilepsy, and vertigo have occurred, and the disease is certainly most frequent in neuropathic individuals. Symptoms of peripheral neuritis are rare, and the pathological changes described in the peripheral nerves are probably the result and not the cause of the disease. Psychical affections, such as mania, melancholia, or dementia, are sometimes present. *Paroxysmal impairment of vision* has been recorded, sometimes alternating with the attacks of local cyanosis. During such visual impairment the retinal arteries have been seen ophthalmoscopically to be in a state of contraction.

Morbid Anatomy.—No constant morbid changes have been authenticated in the vascular system or in the central or peripheral nervous system, and although endarteritis, arterial thrombosis, endophlebitis, and neuritis have all been described, yet more often the vessels and nerves have been found normal. Cases in which pathological changes have been found have chiefly been in limbs amputated for gangrene, in which the morbid appearances were probably consequent to the gangrene and not its cause.

Pathology.—The paroxysmal nature of the vascular disturbances points, as Raynaud himself stated, to a central rather than a peripheral source for the disease.

Local syncope is undoubtedly due to a local spasm of the vessels, its sudden appearance and disappearance being incompatible with any other hypothesis.

The occurrence of local cyanosis has been variously explained. Raynaud attributed it to inequality between the spasm in the veins and that in the arteries, the veins regaining their normal calibre whilst the arteries still remain contracted, the cyanosis being due to reflux of venous blood into the capillaries. He recalled the observation, in this connection, of contraction of the retinal arteries during certain cases of local cyanosis.

But local asphyxia often arises without a previous stage of local syncope. This can hardly be accounted for otherwise than on the hypothesis of a primary venous spasm, causing capillary stasis and cyanosis. Waves of venous spasm have actually been observed in certain cases. Hutchinson holds that the pathological process is not the same in every case, and that, just as in some healthy people, cold causes pallor, whilst in others cyanosis or redness is produced, so in Raynaud's disease, if the spasm is chiefly arterial, pallor results—if chiefly venous, cyanosis occurs.

The sensory symptoms in the affected parts are probably due to imperfect blood-supply. The trophic changes, in the form of gangrene, are more difficult of explanation. Mere vascular spasm, however prolonged, does not readily produce necrosis of tissue, though it may seriously damage its vitality and render it less resistant to slight traumatisms. Those cases of gangrene preceded by cyanosis, but without local syncope, must be associated with an excess of venous blood, and yet profound cyanosis in other parts of the body is possible without producing gangrene. Probably the gangrene of Raynaud's disease is neuropathic in origin, and analogous to the glossy skin of nerve injuries or to the bed-sores of acute myelitis.

The symmetry of the affection and its paroxysmal nature clearly point, as Raynaud indicated, to a central affection, probably an increased excitability, of the vaso-motor centres, rather than to any mere peripheral lesion. The disease is thus an *angio-neurosis*, in which the nervous system is primarily at fault.

The cause of such increased excitability of the vaso-motor centres appears to vary in different cases. Thus the condition may be congenital in cases where there is a nervous heredity, or it may result from various pathological influences, for example cold, long-continued or frequently repeated. Or it may be the direct result of toxins acting on the nerve centres, as in fevers, syphilis, malaria, or intestinal obstruction, or it may conceivably be reflex from peripheral sources. Finally, Raynaud's disease may occur in the course of organic diseases of the central nervous system, in which, along with other structures, the vaso-motor centres happen to be implicated.

DIAGNOSIS.—A well-marked case of Raynaud's disease usually presents no difficulty in diagnosis; it is chiefly with abortive or atypical forms of the disease that one is in doubt. Thus a paroxysm of *erythromelalgia* may resemble the rarer variety of Raynaud's disease in which redness is present instead of cyanosis. In some cases the diagnosis between the two conditions is so difficult as to be impossible, and the greater the number of cases observed, the more arbitrary does the division between them appear. The occurrence of trophic changes, however, in a doubtful case would tend to place it under the category of Raynaud's disease.

Morvan's disease, a variety of syringomyelia, with marked trophic changes in the fingers and toes, is not paroxysmal, but of slow onset. It is less strikingly symmetrical than Raynaud's disease, and is, moreover, accompanied by dissociated sensory paralysis and often by muscular atrophy. Painless abscesses and whitlows, together with necrosis of bone, are common in Morvan's disease, whilst in Raynaud's disease they are rare.

Frost-bite may at first sight be difficult to distinguish from Raynaud's disease, all the more so since the latter condition is often precipitated by cold. A symmetrical distribution, however, is against frost-bite, and a history of previous attacks at a time of year when there was no frost, and especially the paroxysmal nature of the symptoms, would indicate Raynaud's disease.

In chronic *ergotism* (an exceedingly rare affection) the condition is usually epidemic, and there is a history of contamination of rye bread.

Senile gangrene usually affects the whole foot, and is rarely symmetrical, or attacking individual toes, whilst Raynaud's disease quite as often affects the upper as the lower extremities, is more superficial as a rule, and generally affords a history of previous attacks.

Diabetic gangrene is generally of the moist variety, and is associated with endarteritis, neuritis, and glycosuria.

Leprosy, beri-beri, congenital cyanosis, and hysterical blue œdema, need only to be mentioned to be at once distinguished from Raynaud's disease.

PROGNOSIS.—Raynaud's disease is not of itself dangerous, nor does it shorten life. The paroxysms, however, tend to recur again and again, especially in cases of local cyanosis. Cases which go on to gangrene tend ultimately to pass off. The prognosis in individual cases is difficult, inasmuch as slight cases may afterwards go on to gangrene, whereas threatened gangrene may become arrested.

Treatment.—Little can be done beyond the avoidance of cold and keeping the extremities warm during the attack. The patient should wear warm woollen gloves, not too tight. During a paroxysm the pain may require morphia. Other drugs, such as atropin, chloral, or the nitrites, have proved of little avail. Raynaud recommended galvanism to the spine, and obtained encouraging results in certain cases. Barlow advocates local galvanism, the limb being immersed meanwhile in salt water, into which one electrode is led, the other being applied higher up the limb. Gentle massage between the paroxysms is to be recommended. Counter-irritant applications must be avoided. In malarious cases quinine should be exhibited, in cases with arterio-sclerosis iodide of potassium, and in syphilis anti-specific treatment should be carried out. Gangrene should be dealt with on surgical principles.

Erythromelalgia

The group of symptoms included under this name, originally described by Weir Mitchell of Philadelphia in 1872, consists essentially of paroxysmal pain, redness and swelling, chiefly, though not exclusively, affecting the feet. Lewin and Benda, who collected forty-one cases, were the first to point out, in 1894, that erythromelalgia is not a disease of itself, but occurs in the course of many nervous disorders. The affection is not a common one. Cassirer in 1901, after an exhaustive examination of the literature on the subject, had collected ninety instances in all.

Etiology.—*Sex.*—A slight majority of cases, as in Raynaud's disease, has occurred in males. The *age* of onset has mostly been in middle life, between the ages of twenty and sixty, though neither extreme of life is exempt. *Occupations* which entail severe exertion with long hours of standing, or exposure to varying temperatures, appear to act as remote predisposing causes. Thus tailors, who have to sit in an awkward position at work, and fishermen, engine-drivers, and washerwomen, who are exposed to cold and wet, have been specially frequently affected. Previous illnesses may predispose by lowering the general vitality, but the symptoms often appear in apparently healthy individuals. Toxic causes, such as syphilis, alcoholism, malaria, etc., do not play a part of much importance. Local traumatism has occasionally preceded an attack, whilst cessation of the menses, whether accidental, as from falling into a river, or physiological as at the menopause, has also been noted as preceding the first attack.

Symptoms.—The chief symptom consists in a peculiar burning or stabbing *pain*, generally affecting one foot, sudden or gradual in onset, and often of excruciating intensity. This pain is intermittent, and recurs at varying intervals in attacks lasting from a few minutes to several hours at a time. It is made worse by a dependent posture of the limb, by voluntary movement or by warmth, whilst it is relieved by a horizontal posture, by rest, and by cold applications.

Redness and *swelling* of the affected area of skin are superadded, though often not until several weeks or months after the first appearance of the pain. More rarely the redness and swelling precede the pain. The redness is of a bright tint. Its area may be diffuse; more often it is circumscribed at first, affecting, for example, the ball of the hallux or of one of the other toes, the heel, or the outer or inner side of the foot. Sometimes several discrete patches occur. This redness spreads, increases in intensity and, if the vertical position of the limb be maintained, there appears turgescence of the skin with bounding arteries and venous dilatation. This swelling of the skin occasionally pits on pressure; more usually this is not so. After some minutes or hours the "vascular storm" partly subsides, the hyperæmia becomes passive instead of active, the arteries throb less violently, and the bright red gives place to a bluish, dusky, cyanosed tint which persists for some little time.

During the red phase the pain becomes progressively more intense, and there is exquisite tenderness to all varieties of stimuli in the affected part. The plantar reflex, in cases affecting the foot, is exaggerated or normal. The patient during a paroxysm takes off his shoes and stockings, or plunges the foot into cold water, or if he be in bed, finds even the pressure of the bedclothes on the foot intolerable.

The local temperature during an attack usually rises, and may be 2° or 3° C. higher than in the unaffected foot. Instead of the normal fall of local temperature on letting a limb hang down, the converse condition occurs, in which the temperature rises when the limb is dependent, and falls when raised to the horizontal posture. When cyanosis supervenes the temperature of the affected foot falls.

The above symptoms are paroxysmal, not continuous. The effect of the dependent posture in producing pain, redness, and swelling is often instantaneous, so that the sufferer refuses to walk, or, if he walks, treads only on the unaffected part of the foot, or may even, during a severe attack, go on his hands and knees.

The *distribution* of the symptoms is primarily asymmetrical. The feet are chiefly affected, the hands less frequently. The pain may spread up the limb as far as the knee or forearm. When more limbs than one are affected, all are not attacked at once, but first one and then another. When the hands suffer, the characteristic attitude is one in which they are crossed over the breast or raised above the head. Less frequent sites of the affection are the middle of the back, the area of the neck behind the mastoid process, the testicle, or the mucous membrane of the mouth and pharynx.

Besides the cardinal symptoms above described, various concomitant local symptoms may be present. Thus *secretory* changes in the form of excessive sweating of the affected area may occur during a paroxysm. *Trophic* changes in the skin occur in a certain proportion of chronic cases; thus the skin and subcutaneous tissues may become either thickened or atrophic and glossy, and the nails may become coarse in texture. In one case observed by the writer desquamation of the affected area occurred after each paroxysm.

As in Raynaud's disease the motor functions remain unaffected. Slight diffuse wasting of the muscles may occur, but not in the area of individual nerves. Electrical reactions of degeneration do not occur, nor are adjacent nerve-trunks tender as in peripheral neuritis.

Atypical cases are sometimes seen in which the vaso-motor symptoms are intermediate between erythromelalgia and Raynaud's disease. Thus the pain of erythromelalgia may be accompanied by the pallor and subnormal temperature of "local syncope," or even by cyanosis. Or redness and heat may be preceded by pallor and coldness. Or the symptoms of erythromelalgia and of Raynaud's disease may follow each other in the same person.

Morbid Anatomy and Pathology.—Very few cases have afforded opportunities of pathological investigation, and in most of them observers have been content with the examination of portions of the nerve-trunks adjacent to the affected parts. Out of six such cases, in three the nerves were normal, one showed neuritis, and in another there was some degeneration in certain posterior roots of the cauda equina. In three of the six cases arterio-sclerosis was present.

As to the pathology of the affection, although its most striking signs are doubtless vaso-motor in origin, yet the superaddition of sensory, secretory, and trophic changes indicates that the vaso-motor system cannot alone be to blame. The cause of the paroxysms must accordingly be referred to some irritative condition of various nervous centres. The site and nature of such irritation are still matters of speculation. They cannot be referred, as some have supposed, to the sympathetic alone, since the pain is entirely disproportionate to that which occurs in any lesion of the sympathetic chain. One must rather look for the site of the disease in some place where sensory and vaso-motor fibres are closely associated, that is, in the spinal cord or medulla. In support of such a view may be urged not only the paroxysmal nature of the affection, but also the fact that in not a few cases erythromelalgia is one of the earliest symptoms in organic diseases of the cord. The presence of erythromelalgia should lead the observer to ascribe any subsequent nervous phenomena to organic rather than to functional disorder.

It is not improbable that the site of the mischief is not always the same, and that in different cases the peripheral nerves, the spinal cord, or the medulla, may be at fault. Thus those cases which follow more or less closely the distribution of peripheral nerves may be due to neuritis affecting especially the vaso-dilator and secretory fibres, whilst cases which are diffusely distributed over a whole limb or several limbs may be referable to some central cause, spinal or bulbar.

Diagnosis.—In well-marked cases this is usually easy. Painless vaso-motor changes should not be classed as erythromelalgia, and, conversely, pain alone is not diagnostic. As already explained, cases occur in which the demarcation from Raynaud's disease cannot be sharply drawn.

From neuritis it is distinguished by the absence of muscular atrophy and of anæsthesia, from ordinary neuralgia by the absence of the "tender points" and by the presence of vaso-motor phenomena. Intermittent limp—*intermittirende Hinken*—is a condition associated with arteritis of the peripheral vessels of the lower limbs, in which pains and paræsthesiæ come on in the legs on walking and pass off with rest. It is distinguished by the feebleness or absence of pulsation in the accessible arteries of the foot, and by the absence of the redness of erythromelalgia.

Prognosis and Treatment.—The disease, though chronic, is not of itself fatal. It may reach a certain degree of intensity, and then become stationary; more often it is gradually progressive in intensity and distribution.

The treatment during a paroxysm consists in elevating the limb to a horizontal posture, the avoidance of movement, and the local application of cold.

Faradism in a few cases has been beneficial. In one case observed by the writer, a galvanic current, with the positive pole applied to the painful area, promptly relieved the pain.

Drugs are of minor importance, though phenazone, acetanilide, iodide of potassium, etc., have all been suggested. Morphia is a *dernier ressort*, and not rashly to be recommended. Operations on the peripheral nerves have been unsatisfactory, producing at the best only temporary relief, and in one case having been followed by gangrene.

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Rectocele. *See* Rectum, Pelvis, etc.

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Rectal diseases are among the most common that affect civilised humanity. Improper food and alcohol, sedentary indoor occupations, and defects in clothing, have much influence in the causation of these maladies, which, though not usually dangerous to life, certainly give rise to a vast amount of suffering, and also to the distress arising from inability to work for daily bread.

The majority of these affections are very amenable to proper treatment. Some forms of rectal disease are much more common than others, notably fistula and piles.

In hospital practice fistula is more common than piles, but in private practice hæmorrhoids of various kinds are more frequently met with.

There are certain questions which it is desirable to ask the patient when investigating a case of rectal disease.

These refer to:—

(1) The presence or absence of pain, and its nature and position.
(2) Protrusion on action of the bowels, or on exertion.
(3) Nature of discharge if present.
(4) Constipation or diarrhœa.

It is not uncommon for stone, cystitis, prostatitis, or urethral stricture to give rise to rectal symptoms, which may be most prominent, and mislead a patient to suspect the rectum when the urinary organs are really the seat of his disease. In women the condition of the uterus must be ascertained.

Verbal interrogations concluded, an examination is to be made. The most comfortable and delicate position for the patient, and the most convenient for the surgeon, is obtained when the former lies on the right side, face and chest turned towards the couch, right arm behind the back, and knees drawn up to the abdomen. The buttocks are then in an oblique position, and leave the surgeon a good view of the anus. In special examination for growth or stricture the patient should be directed to stand up and bear down. Great gentleness must always be used in the examination. Note any discoloration and the condition of anus, whether patulous, contracted, or nipple-shaped. Look for tumour, ulceration, or fistulous openings; feel around the anus for induration. Press on the very verge of the anus, for a painful spot may be found indicating the position of a fissure. With the hands placed upon the buttocks, and the fingers near the anus, separate the former, telling the patient to bear down. The anus is thus everted, and the orifice and mucous membrane for half an inch up the bowel exposed to view. Fissure, piles, or polypi are thus discovered. Now examine the interior of the bowel with the finger well anointed, the patient bearing down as it is inserted. The tightness and breadth of the sphincters are observed, and careful examination made in the space between them, the commonest position for openings of fistulæ. Then the finger is passed higher, and the prostate and upper parts of the rectum thoroughly explored.

If a tumour is felt, try to indent it with the finger. Scratch with the nail, to detect what matter is got from it; impacted fæces may give rise to symptoms of cancer, and blood, mucus, or pus on the nail helps diagnosis. Use the right forefinger for the front wall, and the left for the posterior aspect of the gut.

If the rectum be full of fæces obscuring diagnosis an enema is necessary. A speculum is seldom needed for diagnosis. When used it must be large, and an anæsthetic is required. Should nothing be found to account for the patient's symptoms, the highest part of the rectum and lower part of the sigmoid flexure may be examined by bougies with or without an anæsthetic. First india-rubber, then metal bougies are to be used. Passage of the hand into the rectum for diagnosis of disease high up is of doubtful value. In obscure cases it is most important to give an anæsthetic, dilate the sphincters, and examine the abdomen, pressing deeply into the left iliac fossa.

ABSCESS AND FISTULA IN ANO.—Men are more subject to fistula than women. The disease is commonest in middle-age, but infants in arms, and patients over eighty, have alike needed operation for fistula. The commonest causes are:—

(1) Injury to the anus, as by passage of hard motions or foreign bodies.

(2) Exposure to wet or cold, as by sitting on damp seats after exercise, when the parts are hot and perspiring.

(3) Parasites of the anus and its neighbourhood. Thrombosed veins and suppurating piles are predisposing causes.

(4) Abscess and fistula may follow fevers, and those conditions which give rise to boils and carbuncles; and

(5) Tubercular tendency inherited or acquired may lead to this disorder.

Fistula generally begins by formation of an abscess immediately beneath the skin just outside the anus, starting in the cellular tissue, or hair, or sebaceous follicles. The ischio-rectal fossa is a rarer situation. It may begin in the subcutaneous connective tissue of the rectum, and burst into the bowel. It may undermine the rectum in any direction. In phthisical patients it may begin by ulceration of the mucous membrane, in which fæcal matter accumulates and forms a sinus, opening eventually outside the anus. Abscess may originate in the superior pelvi-rectal spaces, and form sinuses extending in every direction. Rectal abscesses may be acute, chronic, or gangrenous. The acute are accompanied by severe constitutional disturbances, the chronic may be evident only from a painless fluctuating swelling, with thin and discoloured skin, or a flat, boggy, crepitating enlargement by the side of the anus. Gangrenous abscess around the rectum is rare, occurs in persons of broken health, and requires very free incision. Rest, fomentation, and leeches may cut short a threatening abscess if seen early. Usually, however, pus forms, and incision is then the only treatment. The longer an abscess is left unopened the greater is the danger of sinus formation. To open small abscesses, place the patient on the side of the swelling, pass the left forefinger into the bowel, and make outward pressure between this and the thumb; with a straight bistoury held perpendicular to the abscess, open it, cutting outwards, and making the incision at right angles to the anus. In severe cases open the abscess from end to end, and from behind forwards. Introduce the forefinger, and break down any secondary cavities, carrying the finger up by the side of the rectum till only one large sac remains. If there is outward burrowing, make a deep incision into the buttock at right angles to the first. Do not cut away sloughs. The cavity is syringed out, and filled with wool soaked in iodoform and vaseline, 20 gr. to ℥j. After twenty-four hours this is changed daily, the wool being very lightly carried to the bottom of the cavity, which must *not be stuffed.* Fistula often follows abscess owing to the movement of the part by the action of bowels and sphincters, the presence of much loose areolar tissue and fat, and the unsupported state of vessels near the rectum.

Fistulæ are:—

(1) Complete, having an opening inside and outside the bowel.
(2) Blind external, having no internal opening.
(3) Blind internal, having no external opening.

In almost every case of complete fistula the internal opening is between the two sphincters. Fæces when liquid, passing into complete or blind internal fistulæ, cause great suffering—burning pain often lasting for hours after an action of the bowels. Any fistula may become complex by the formation of many sinuses. As regards the seriousness of a case, the most important point is whether the sinuses are low down in the rectum or surrounding tissue, or high up as the result of abscess in the ischio-rectal fossa, or above the levator ani muscle. In examining fistula use the probe with a very light hand, letting it find its own way.

If operation is not at once desirable, palliative treatment may be tried if:—

(1) There is no internal opening.
(2) The discharge is thin and watery.

There may be more than one internal opening. The internal opening must be felt with the finger, a tortuous course of the sinus often preventing the probe from reaching it.

In horseshoe fistula the sinus generally runs dorsally from one side of the anus to the other. In children fistula is generally due to worms, and is cured by removing them; a saline iron mixture should be prescribed in addition to the usual vermicide remedies. In adults palliative treatment consists in the application of strong acids, the outer opening of the fistula being first well dilated. Wool twisted upon a piece of stiff wire is passed down the sinus and withdrawn, and then, similarly, wool saturated with the chosen acid. A drainage tube, just large enough to fill the sinus, is inserted, and shortened daily. More than one application of the acid may be needed, and the external opening must be kept dilated. Spontaneous cure of fistula does very rarely occur. Forcible dilatation of the sphincters sometimes leads to cure, but is very uncertain. The patient need only rest for two days after this procedure. When a cutting operation is to be avoided, the elastic ligature may be used if there is only one sinus. For details of this treatment, which is rarely suitable, readers are referred to the author's larger work on *Diseases of the Rectum.*

Operations on Fistula in Ano.—Thirty-six hours before operation an aperient is to be given, and an injection on the morning of the operation. The patient should always be anæsthetised, as the extent of the operation cannot be foreseen, and placed upon the side on which the fistula exists, the buttocks being brought to the edge of the couch, and the knees drawn up. This is the best position for most rectal operations, but with fistula on both sides the lithotomy position should be adopted. A director is passed into the external opening, and if possible through the sinus and internal opening. When, with the finger in the bowel, the point of the director is felt, it is turned towards the anus, and the tissues over it divided with a curved bistoury. If the point of the director cannot be brought out at the anus, owing to the depth of the fistula, it must be passed well through the sinus, and steadied by the left forefinger inserted into the rectum, while a straight knife is run along the groove of the director, cutting towards the bowel until the tissues are severed. This is not an easy operation. Dilation of the sphincters is of great assistance. If there is no internal opening, the point must be found where only mucous membrane intervenes between the point of the probe and the internal finger. If this is the highest point of the sinus, work the point through, and bring it out at the anus. If it be not the highest point of the sinus, gently push the probe farther, and then thrust it through the tissues into the bowel. Unless the sinus is laid open to its whole extent the patient will not be cured. After dividing a fistula from its external to its internal opening, search with the probe for any sinus running up beyond the internal aperture. Search with the finger tip for lateral sinuses from the main track, or for outward burrowing beyond the external opening. There may be a secondary sinus beneath the main one. This is found by scraping away the granulation tissue of the main sinus. When all sinuses have been slit up, the overlapping edges of the skin should be taken off. In cases with much induration draw a straight knife through the dense track of the fistula, and outwards beyond the external opening. When the operation is completed, some fine cotton wool is packed with a probe into the bottom and every part of the wound. A pad of wool over the wounds, and a T-bandage firmly applied, complete the dressing. In this, as in all rectal operations, strict surgical cleanliness must be observed throughout. In cases where, owing to the depth of the sinus and the density of the tissues, the point of a probe director cannot be got out of the anus, the author's spring scissors and special director are recommended. In operating upon horseshoe fistulæ only one division of the sphincter must be made. Press a director through the external aperture, and on to its point incise the skin in the middle line behind; push the director through and slit up. Then slit up the lateral sinuses on directors passed in at the external openings, and brought out at the dorsal incision. Most horseshoe fistulæ are dorsal. Incontinence of fæces does not follow operations upon these cases if the internal sphincter is not divided, and if all loose mucous membrane or piles that may be present be thoroughly removed, so as to insure some contraction of the anus. Internal fistulæ are often connected with hæmorrhoids, and sometimes follow suppuration caused by application to these of strong remedies. The internal opening may be detected only with difficulty, appearing as an ulcer which must be searched with the probe. In operating upon women cut as little as possible.

Incontinence of fæces results from cutting the muscles, particularly the internal sphincter, in more than one place. On one side the sphincters may be divided quite through without harm if the incision is at right angles to the fibres of the muscles. After operation for fistula the bowels should be confined for three days. The wool should be well moistened and removed a little day by day, beginning on the day after operation. After action of the bowels syringe the wound daily with warm antiseptic lotion, and lay a little cotton wool lightly along the whole track. Fresh sinuses are generally indicated by sudden increase of discharge. Whenever a wound secretes more than its surface seems to warrant, or pus oozes up on pressure, search diligently for the sinus. Burrowing has certainly commenced. Patients should be encouraged to state when they have pain in or near a healing fistula, this may lead to early detection of small abscess or sinus. The length of time that a recumbent posture is to be maintained depends upon the general health and extent of the wounds. Patients need not be kept long in bed, but should be made to recline upon a sofa. Never, if it can be avoided, operate upon a fistula that is acutely inflamed. A free dependent opening only should be made, and the patient rested till all inflammation has subsided.

Incontinence of Fæces; Causes and Treatment.—Incontinence may result from injudicious operation, even on ordinary fistulæ, or from extensive fistulæ. This distressing symptom is associated with three conditions of sphincter:—

(1) Too deep a cut has been made through both sphincters, and the wound in healing has left a deep sulcus.

(2) The sphincter has been divided in two places, and weak splicing has ensued, the muscles being divided obliquely instead of at right angles to their fibres. Cicatrices are seen and felt, one each side of the bowel.

(3) In women the anal sphincter has a weak point in the perinæum, owing to decussation with fibres of the sphincter vaginæ. When this point is incised loss of power results. In these cases little is found on examination, except that the scar shows the fistula to have been perineal.

A single operation may succeed in curing any of these conditions, but many may be necessary, and months may elapse before a satisfactory result is obtained. In most cases, however, free application of the rectal cautery is to be employed. The external and internal sphincters are deeply burned in several places, the old scars cauterized, and the tissue just around the anus burned into. The wounds are to be dressed with wool saturated in olive oil. After-treatment needs great care, daily passage of the finger keeping contraction within due bounds, and soft motions being habitually procured. In the condition first described, where there is a sulcus, the old scar tissue may be cut away, and the wound united by catgut sutures. In the second condition the cautery affords the only hope. In the third condition Lawson Tait's operation on the perinæum may be performed, and the flaps turned into the rectum.

Fistula in conjunction with phthisis requires special consideration, particularly as regards the question of operation. *Tubercular fistulæ* are commonly distinguished by the following attributes:—

(1) Fistula begins with a chronic abscess, which is frequently painless;
(2) The external opening is large, ragged, and irregular in form;
(3) The internal opening is large;
(4) The sinuses are soft, and felt as gutters or depressions below the skin;
(5) The skin around the external opening is blue and unhealthy looking;
(6) Discharge is thin and watery, and tubercle bacilli may be found in it;
(7) The buttocks are thin, and the ischio-rectal-fossa depressed;
(8) There is an excessive amount of hair which is long and fine;
(9) The sphincters are weak, little resistance being offered to the introduction of a finger.

Fistula with some or all of these characteristics may be met with in persons:—

(1) The subjects of active tuberculosis;

(2) Who have had hæmoptysis, and still have remains of a cavity or consolidation of apices;

(3) Who have the family history of phthisis, but no direct evidence in themselves, except the fistula.

In the first class only such operation as is necessary to relieve pain will be recommended; in the second, operation with very careful limitation of incision; and in the third, an early and free operation to rid the patient from a possible source of future infection. These patients are generally better subjects for chloroform than for ether. After operation these patients should not be kept strictly on the back or side, as usually after an operation for fistula. They should be allowed up, or in a sitting position, even from the day after operation. Careful feeding, drug, and climatic treatment will help to a favourable result.

HÆMORRHOIDS.—Piles are generally described as being—

(1) Internal or "bleeding";

(2) External or "blind";

and the distinction is as a rule well marked, although internal hæmorrhoids may so prolapse as to be mostly external, and external piles may encroach upon the mucous membrane within the anus. External piles are the less important. They are of two kinds: the first being hypertrophies of skin, exaggerations of the surface of the anus; and the second, venous tumours rounded or elongated, situated at the verge of the anus, or passing up into the bowel. External piles cannot be reduced within the anus. Internal piles, if protruded, can be so reduced by gentle pressure, and thus in doubtful cases a diagnosis may be made as to which of the two kinds, or whether both are present. When both kinds are present the case must be regarded as one of internal piles. External hæmorrhoids are so common that few persons reach middle age without suffering from them in greater or less degree. So great a variety of causes helps to their formation that no class of persons is exempt, but those suffer most perhaps who are prone to rich living, excessive smoking, sedentary occupations, or violent prolonged exercise. Straining at stool, the use of cheap printed paper as a detergent, constipation, and pregnancy are some of the factors very commonly present. Either variety of external pile—the simple skin hypertrophy and the varicose clot-containing vein—is liable to acute attacks of inflammation. Extra eating and drinking are often the exciting cause of these. A sensation of fulness and pulsation in the anus, followed by itching of a most annoying nature, is the first symptom. The anus is a little swollen and tender, and there may be a stain of blood when the bowels act. All this may pass off with simple treatment, but if neglected will precede a more severe attack. One common mistake, to suppose the piles internal, and attempt their reduction, must be carefully guarded against. The necessary treatment consists in spare diet, rest, reduction of smoking, an aperient pill, and the local application of a sedative and astringent ointment or lotion. Common and efficient prescriptions are—Bismuth subnitr. ʒij., Hyd. subchlor. ʒj., Cocaine, gr. iv., vaseline ad. ℥j.; or Liq. plumbi. subacet. ℥j., Liq. opii. sedativ. ʒss. A tumbler of Vichy water or Carlsbad salts, taken on rising, is often a useful adjunct. If, through delay in treatment, more acute inflammation sets in, the piles become much increased in size, œdematous, or shiny, and very painful if touched. By irritation they cause spasm of the sphincter and levator-ani muscles, giving rise to acute pain just as the patient is falling off to sleep. He is generally feverish and constipated. Warm applications are in this state generally better than cold, but sometimes ice gives much relief. Treatment as recommended above will probably cure the attack, but if desired, operation may be at once undertaken. It is to be recommended—

(1) For the saving of time;
(2) To prevent recurrence;
(3) If the pain is great, and unrelieved by palliatives.

In the case of the hypertrophied skin tumours, operation consists in removing them with scissors, and may be done under gas. Care must be taken not to remove enough skin to induce subsequent contraction. The venous piles are to be pinched up between finger and thumb, and the basis transfixed with a curved bistoury, which is made to cut out. Pressure extrudes the clot, and fine cotton wool is then placed at the bottom of the sac. The incision is made in the direction of the radiating folds of the anus. If unoperated on these tumours may form cutaneous flaps, the blood in them becoming absorbed.

Internal Hæmorrhoids.—All causes of external piles tend to the production, too, of internal, but these may also represent a family idiosyncrasy. Pregnancy, which often causes external piles that pass away after labour, has a different relationship to internal hæmorrhoids which appear after parturition, when the parts are relaxed and involution is taking place. Internal piles have been attributed to anatomical peculiarities of the superior hæmorrhoidal veins, but their diverse structure is against this view. They may be—

(1) Capillary;
(2) Arterial; or
(3) Venous.

The first are small, florid, raspberry-like looking vascular areas on the mucous membrane, with a granular surface that bleeds on the slightest touch. They consist of hypertrophied capillary vessels, and spongy connective tissue, and closely resemble arterial nævi. After a long time, or after strong applications, they lose their granular appearance, and may remain dormant for longer or shorter periods when they grow again. Arterial hæmorrhoids are sessile or slightly pedunculated tumours, with glistening or slightly granular surface, and having an artery, often as large as the radial, entering the upper part. They consist of numerous freely anastomosing vessels, tortuous, and sometimes dilated into pouches, and a stroma of connective tissue.

In the third variety of internal piles veins predominate. The tumours are often as large as a hen's egg, of bluish or livid colour, with a smooth or pseudo-cutaneous surface. Ordinary piles of long standing, causing discharge rather than bleeding, have been spoken of as "white piles." Partial prolapse of the mucous and submucous membrane of the rectum much resembles, but is to be distinguished from piles. There is no definite tumour, and no hypertrophy of vessels.

Capillary piles can be diagnosed only by symptoms and ocular inspection; they cannot be felt. Pains in the back, in the spermatic cord and testicles, and small daily losses of blood, are commonly met. It is this form of the disease that may be benefited by application of carbolic or fuming nitric acid. The treatment is uncertain, even with capillary piles, and never to be used with the arterial and venous forms. Powerful astringents, as liq. hamamelis, twice daily, or suppositories of sulphate of iron, are similarly sometimes effective with capillary piles. Arterial and venous piles have many symptoms in common, and the suffering they cause depends more upon the condition of the tumour, as regards inflammation or ulceration, than upon its exact histological nature. In the early stages of the affection the piles come down at stool and bleed, returning within the sphincter after the bowels have acted or when the patient rises, or at least upon his lying down and voluntarily retracting. Later, pressure is needed. On their return they come outside the sphincter on the slightest exertion, discharge mucus, bleed independently of action of the bowels, and cause a constant sense of weight above the anus, the patient feeling as if the bowels were never properly relieved. Cutaneous hypertrophies are generally present around the anus. These are irritated by the discharge, becoming inflamed and very tender. Sometimes a number of polypoid growths are studded over the mucous membrane. Arterial and venous piles can be felt on examination as tumours bulging from the rectal wall with well-marked sulci between them. If scratched they bleed freely. Arterial piles are less dependent upon constitutional causes, and have less tendency to prolapse than the venous.

Treatment.—Palliative treatment has little effect upon arterial piles. With venous piles it may materially alleviate, if not cure, the disease. Such treatment consists in regulating the diet and mode of life, careful regulations of the bowels, the use of cold water injection after their action, and the application of suitable astringent ointments. Advanced cases need operative treatment.

Treatment of Protruding Piles.—If the piles have just come down the patient should lie prone with pillow under the pelvis. Wool saturated with 20 per cent cocaine solution is left on the piles for ten minutes; the finger is then passed up the bowel, while gentle attempts are made by pressure with the other hand to empty the piles of blood. If this fails a bladder of ice should be placed over the part for one hour, and then taxis again tried. This again failing, apply cocaine ointment and make no further attempt at reduction. If the piles have been down for some time and are inflamed or even sloughing, and cannot be returned, they must be treated with ointment and fomentations. If they can be returned, but immediately prolapse again, the same treatment is to be used. It causes profuse suppuration with speedy separation of the sloughs. Stimulants and tonics are often necessary in such cases. In pregnancy piles should be operated on only if there is much loss of blood and great suffering. The recumbent position is to be kept longer than with other cases. In women the subjects of uterine displacement this must be remedied before any operation for piles. Complicated cases of disease of rectum, uterus, and bladder are common and most difficult to remedy. When piles are causing serious loss of blood every day's delay in operation is to be deplored, and no consideration should lead to postponement of the only measure which can effectually relieve the drain upon the strength.

Operations for Internal Hæmorrhoids.—Thirty-six hours before operation, two pills are to be given, composed of: Pil. hydrarg. gr. j., Pil. col. et hyoscy. gr. iv. When the piles are venous, and in some plethoric patients, a longer course of preparatory treatment is desirable; while in the very anæmic less drastic purges are better. On the morning of operation an enema is given. The patient is placed upon the right side at the edge of the bed. The assistant stands with his back towards the patient's head, raising the upper buttock with his right hand, and with the right elbow hooked over the patient's pelvis, thus controlling the position. There are several operations from which to choose in treating hæmorrhoids. Before describing that by ligature, which we recommend in the vast majority of cases, we will briefly allude to others which may in certain cases be preferred.

(1) Excision by Knife or Scissors.—This must only be done when the piles are not large, vascular, or numerous. The so-called "white pile," partially prolapsed mucous membrane, and the single perineal pile, so frequently found in women, are conveniently operated upon in this way. The sphincters are first gently, but fully dilated. The pile is seized at the base by a vulsellum and cut off. The vulsellum is kept in place till any spurting vessels have been clipped and twisted; rarely more than two require attention. When bleeding has ceased, cotton wool soaked in solution of tannin and water (equal parts) is placed within the anus as high as the scissors have cut.

(2) The ecraseur formerly often used has now no recommendation in operating for piles. Its use is followed by intense and prolonged pain.

(3) Application of Strong Acids.—This must be reserved for the treatment of small granular piles or patches of villous bleeding mucous membrane. Eucaine (4 per cent) is applied, and the area to be treated surrounded with wool soaked in bicarbonate of soda. The surface is then dried and the acid applied several times with a small wooden brush. The parts are then washed, oiled, and returned within the sphincters.

(4) Injection of Carbolic Acid.—The advantages of this method are that confinement in bed is not necessary, and it can be employed without a general anæsthetic. Its great drawback is that it is far more dangerous than any other method of operating. Dangerous hæmorrhage, embolism of the liver, and many deaths have followed injection. The injections are made with a hypodermic syringe, and may have to be repeated after a fortnight. Injection should never be performed when there are many piles, or when a pile is one which cannot be completely returned within the sphincters. Injection may stop bleeding and diminish prolapse, but it is not to be regarded as a cure.

(5) Cauterisation.—There is the same objection to this as to the injection method. A slough or inflammation is produced, the extent of which is beyond control, in the interior of a vascular tumour not cut off from the general circulation. The cautery must be used only in the case of a capillary pile, the point is to be freely applied all over the bleeding area, but not to penetrate deeply the wall of the bowel. There is no advantage in employing a galvanic cautery. Paquelin's is simple and preferable.

(6) Removal by clamp and scissors, bleeding being arrested by the heated iron. This "clamp and cautery" operation is six times as dangerous as the ligature, leaves great pain, and a greater likelihood of secondary hæmorrhage, and there is more often troublesome subsequent contraction.

(7) Dilation of the Sphincter Muscles.—In some cases when the piles on protrusion are tightly gripped by the sphincters, become swollen, and perhaps bleed freely, speedy relief and even a cure may result from mere dilatation of the sphincters, gently but fully carried out. The method is of little value in other cases unless the hæmorrhoids have existed only a short time. The operation of dilatation is of great use for the mere relief of pain in cases where for any reason a more radical proceeding is to be avoided.

(8) Treatment by Crushing.—This method is better than the "clamp and cautery." It may be used when the piles are small and not more than three. It should not be used for inflamed piles nor in cases of anæmia. The author's screw-crusher is recommended as giving less chance of recurrent hæmorrhage, and details of the operation are given in his larger work. The operation is safe in chosen cases, but is rarely to be preferred to the ligature.

(9) Whitehead's Operation.—Theoretically, this proceeding, which is

based upon complete removal of the pile-bearing area, is excellent. Practically it is unnecessarily extensive, and one of the worst operations for piles. Moreover, recurrence is more likely after this than after operation by the ligature, and the proceeding requires about six times as long as the latter. Three evil results that have frequently followed this operation confirm our opinion against it—

(*a*) Anal stricture.

(*b*) Loss of sensation in and power over the anus.

(*c*) The mucous membrane, stitched down to the skin around the anus, adheres outside it. The mucous membrane is exposed to irritation, discharges mucus, and bleeds. We do not give a detailed account of the operation because its performance is not recommended.

In these very rare cases in which the entire circumference of the rectum is to be excised for piles, Mr. Thelwall Thomas's modification of Whitehead's operation is the quickest and safest method. The chief point is in the method of suturing the bases of the piles, for description of which the reader is referred to a larger work on the subject.

(10) Operation by Ligature.—This is, as above stated, in our opinion the safest and best operation for the great majority of cases of hæmorrhoids. It is begun by complete dilatation of the sphincters. The hæmorrhoids are drawn down one by one, and with sharp scissors separated from their connection with the muscular and submucous tissues. The cut is made in the white sulcus where skin and mucous membrane meet, and carried up the bowel parallel to its axis till the pile is left connected by an isthmus of vessels and mucous membrane only. As the larger vessels come from above and enter the pile just beneath the mucous membrane they are unaffected by this incision. A strong silk ligature is placed in the deep groove now made and tightly tied with three knots, while the assistant draws the pile well out. If the pile be very large a portion may be cut off, enough being left to guard against the slipping of the ligature. A strip of wool saturated with iodoform ointment is passed into the bowel, and a pad of wool over the anus firmly secured by a tight T-bandage. It is most important when there are many piles, that the base of the ligature should be as narrow as is consistent with non-division of the chief arterial supply; otherwise too great a narrowing of the rectum is produced. In 5000 cases of this operation we have had only 5 fatal results. Other surgeons show an equally satisfactory experience of the procedure.

After-treatment.—The bowels should be confined for three days. A hypodermic injection of morphia is given just after operation, and repeated if necessary for pain during the first twenty-four hours.

In very bad cases and in delicate persons the bowels should not be allowed to act for even four days or more. Diet should be light and such as leaves little residue. There must be no alcohol and complete rest in bed. When retention of urine occurs the patient should kneel in bed with warm flannels over the pubes. After twenty-four hours the pad of wool is changed, and the strip inside the bowel removed after forty-eight. A pad soaked in sanitas is then kept applied. On the third night pil. hydrarg. gr. ij., Pil. col. c. hyoscy. gr. viij., are administered. When the bowels act the patient, unless anæmic or ill, may get out of bed. There is often pain and a little blood with the first motion. If there is much straining the bowel is to be examined for the presence of hard fæces, which must be broken up with the finger, an enema of warm gruel and olive oil being then given. After the first action of the bowels fomentation is to be applied. A daily action by suitable mild laxatives is now to be secured. The wounds are dressed daily with antiseptic lotions or ointments suitable to the condition present. A weak antiseptic solution is syringed in after every action of the bowels. The dressing consists of a small strip of wool for each wound carrying the lotion or ointment prescribed. After the first week the finger is passed daily to make sure that no contraction results. The patient may now get up daily to lie for a few hours on a sofa. He must not remain long in the erect position, for, though convalescent, his wounds are not yet healed. Rest must be insisted upon until the bowel is felt to be healed. Ligatures usually separate about the eighth day.

The following conditions are often found in conjunction with hæmorrhoids:—

(1) Fissure.—A small painful ulcer is often present in cases of piles, and is commonly overlooked because a careful examination is necessary to find it, hidden as it is by one of the hæmorrhoidal tumours. Pain on defæcation or long after the bowels have acted should always lead to suspicion of fissure.

(2) Fistula is not so common a complication, but is sometimes present, and needs care for detection if it be of the blind internal kind.

(3) Polypus and polypoid growths are sometimes found with piles. They must be removed at the operation, or they may prevent healing of the wounds.

(4) Impaction of fæces is sometimes found when the operation for piles is begun. The mass must be broken up and washed away before the surgeon proceeds further.

(5) Lax Condition of Sphincters.—In old persons and in those who have had large venous piles for a long time this condition may be met. In such cases it is not advisable to perform the preliminary dilatation.

(6) Malignant Disease.—In examining a case of hæmorrhoids, the surgeon should never omit to pass his finger well into the bowel before withdrawing it, and thus be sure that there is no stricture, ulceration, or malignant growth.

Complications that may follow the operation for Hæmorrhoids—

(1) Loss of Power in the Sphincters.—When large piles have been removed a sense of weakness and loss of power over the anus may be left. The piles acted as a plug and at the same time caused, from their prolapsing, a weakening of the sphincters. Moreover, the change in the mucous membrane effected by operation brings about a dulness of appreciation when fæces approach the external orifice. Thus the patient may be unable to prevent discharge of wind or motion. If the anus is bathed night and morning with cold water, and an ounce of some stimulating lotion be daily injected into the rectum, the proper power soon returns.

(2) Impaction of Fæces.—Although no fæces may be seen at the operation, large masses may be retained in the large intestines in any case of rectal disease. Delayed healing is often due to such descending masses.

(3) Contraction of Anus.—This is especially likely if the patient is allowed to get up too soon. It usually affects the mucous membrane only, and is cured by daily passage of the finger or bougies. In rare cases, when there has been long healing, or where extensive removal of the wall of the rectum was necessary, a tight hour-glass contraction is found. Constitutional as well as mechanical treatment is generally necessary, as such a condition occurs almost only in weak and unhealthy subjects. The patients are generally women, and there is often some uterine condition which needs care to permit of cure of the stricture in the bowel.

(4) Abscess and fistula should be looked for when suppuration is more profuse than is consistent with the healing of the wound, or separation of sloughs.

(5) Bubo or pelvic suppuration may arise in delicate patients.

(6) Hæmorrhage may be primary, recurrent, or secondary. The first is very rare if the operation is properly done. If no important vessel can be discovered bleeding, a little subsulphate of iron wool is to be introduced into the rectum, pressure applied, and an ice bag placed over the exposed buttocks.

Recurrent hæmorrhage after many hours, or even a day, is more serious. If the treatment just described does not stop the bleeding, and especially if the patient feels distended, there is probably internal hæmorrhage. Prompt action is necessary. Remove the bandage, pass a finger into the bowel, and tell the patient to bear down. Dark blood and clots pour out. Syringe the rectum with cold water. If the bleeding still continues, pass the finger again and find the spot where pressure controls the hæmorrhage. Ether is now to be administered, the nurse continuing the pressure upon the bleeding spot, if another medical man is not at hand. When the patient is properly anæsthetised the nurse must continue the administration while the surgeon pulls down the bowel with a vulsellum, and picks up the bleeding vessel. If it cannot be found clips must be left on the mucous membrane at the place where pressure controls the loss. If this too is ineffectual, the bowel is to be plugged. A No. 12 gum-elastic catheter with the end cut off is passed up the bowel for six inches. A cone-shaped sponge, with strong silk ligature passed through its apex, is passed four inches up the bowel, the two ends of the ligature hanging out. Then the whole rectum below the sponge is to be carefully packed with antiseptic wool or gauze. Now pull the sponge downwards by the ligature, at the same time pushing the stuffing up. In this way the sponge is distended, and no bleeding can possibly take place. The plug is left in about one week, and the patient kept if necessary under the influence of opium. Wind passes by the catheter.

Secondary hæmorrhage may come on at the time of separation of the sloughs. It generally occurs only in elderly subjects of broken-down constitutions. Generally the tissues are too rotten for application of a ligature. Treatment as just described must at once be instituted. Afterwards the buttock and lower part of the bowels are to be kept cool, and a hot bottle put near the head if the patient is faint. Careful nourishment and after-treatment are needed. In women, hæmorrhage from the rectum may be controlled by the fingers in the vagina, making backward pressure against the sacrum.

Procidentia Recti.—Procidentia and prolapse are often confused. Procidentia is a descent of the whole circumference of the rectum, prolapsus is a protrusion outside the anus of a portion or portions of the mucous membrane. Internal hæmorrhoids, when they come outside the anus, are said to be prolapsed.

Procidentia may take place in three ways:—

(1) The entire circumference of the mucous membrane, or all the coats of the rectum, appear outside the anus.

(2) The upper part of the rectum descends through the lower, and appears externally.

(3) The upper part of the rectum descends through the lower part, but does not appear outside.

Constipation is usually a symptom in children, but in the old a diarrhœa with discharge of mucus is more common. In old and bad cases there is more or less incontinence of fæces.

In the third variety there is obstinate constipation, a sensation of burning and fulness with tenesmus, straining, difficulty in defæcation, and occasional discharges of blood and mucus. These symptoms should lead to an examination of the bowel with the patient standing up. The finger passing up close to the front or back wall of the bowel meets an obstruction, then, slightly withdrawn, it will find in the centre of the bowel the orifice of the descending portion. This condition occurs chiefly in the old. The other forms of procidentia are most common in children. Reason for this may be found in the length of the mesentery, though worms, stone in the bladder, phimosis, and polypus recti are also sometimes to blame. Occasionally the cause is indiscernible. When a large portion of the bowel is down there is much difficulty in returning it. Gentle taxis, and pressing up a large flexible bougie, generally succeed. If there is much swelling, rest must be enforced with the buttocks well raised; after a few days the mass may be returned. Constant application of ice must not be made, or serious sloughing may ensue. With children palliative treatment generally succeeds in curing the condition. Any source of irritation is to be removed, and the general health attended to. Sitting and straining at stool are forbidden, the motions being passed while the child lies at the edge of the bed, or stands up, one buttock being drawn aside so as to tighten the anal orifice. Afterwards the protruded part is washed with cold water, and thoroughly sponged with weak carbolic or hamamelis. The bowel is then returned by gentle pressure, and the child kept lying upon its face for half an hour. Mild measures failing, the application of strong nitric acid is the best remedy. An anæsthetic is given, and the protrusion well dried. The acid is applied all over it, and then after being oiled the parts are returned, and the rectum stuffed with wool. A pad is applied outside the anus, and the buttocks are strapped together. The bowels are confined for four days. Then castor oil is given, the plug comes away, and the rectum does not descend. Sometimes more than one application of the acid is necessary.

Procidentia in adults is cured with much greater difficulty. For the first and second varieties, the best mode of treatment is free application of the actual cautery, assisted, if necessary, by opening the abdomen, and pulling up the gut from within. For the third variety, pulling up the gut from within, and fixing it to the abdominal wall, is the safest and best mode of treatment. The cautery is used in the following manner:—

The patient is anæsthetised, preferably with ether, the part if not quite down, is drawn fully out of the anus by a vulsellum. With the iron cautery at a dull red heat, make four longitudinal stripes from the base to the apex of the procidentia, taking care not to burn so deeply towards the apex as at the base. If the procidentia is very large, six stripes may be made. The intestine is then oiled and returned within the anus. The sphincters are partially divided on both sides of the anus by a sawing motion of the hot iron, and a small portion of the oiled wool is inserted. The patient must be kept in bed, and the motions passed lying down. If the wounds are not healed in a month he must continue the recumbent position for another two weeks, by which time it rarely happens that all is not healed. After he is up and about, motions should be passed lying down.

Polypus Recti and Polypoid Growths.—By polypi we mean pedunculated growths attached to the mucous membrane of the rectum, and generally situated not less than one inch from the anus. They may be found two inches up the bowel, but rarely more than that. Generally they grow from the dorsal portion of the rectum. The two common kinds are—

(1) *Mucous or Soft Polypi.*—These are small vascular tumours with pedicle often two inches long. They resemble a half-ripe mulberry. These polypi may bleed very freely. They are true adenomata.

(2) *Fibrous polypi*, which originate from the submucous connective tissue. These may be very hard and have pedicles always attached above the sphincters. In adults polypi are generally neither very hard nor very soft. They are sometimes cystic.

Symptoms. — In children there is frequent desire to go to stool, tenesmus, occasional bleeding with discharge of mucus, and a fleshy mass protrudes when the bowels are acting. When situated high up polypi may be dangerous by causing intussusception. The peduncle is slender, and probably polypi are at times spontaneously cured by separating when a hard motion is passed. In adults there is often the history that without previous discomfort a substance is discovered to protrude when the patient is at stool. This is characteristic. Until the peduncle is long enough to allow the polypus to be protruded or grasped by the sphincters, there is little or no inconvenience, and the onset of the disease therefore appears quite sudden.

This is different from the history of a case of hæmorrhoids. A certain diagnosis is made by passing the finger to its fullest extent, and sweeping round the rectal surface as it is withdrawn. The disease may be mistaken for internal piles, procidentia, or dysentery. An examination after an injection will decide against the first two, and the patient's general condition and nature of his motions against the last.

The only treatment to be recommended is removal of the growth. The peduncle is to be seized close to its base with torsion forceps, and gently twisted till the polypus comes away. There is no hæmorrhage or pain, and no necessity for resting more than one day. If the polypus be large it should be drawn down, and a threaded needle passed through a small piece of the mucous membrane at the base of the pedicle. A knot is tied, and the pedicle then surrounded with the ligature tightly tied. The polypus is then cut off, not too near the ligature. In such a case the patient is to be kept at rest until the ligature separates, and the bowels confined for three days. *Disseminated polypi* constitute a rare disease peculiar to certain families, several members of the same family being affected. The symptoms resemble those of the soft polypus in children. The treatment is of uncertain result. Attempts to relieve by means of astringent injections are futile, and the most efficient treatment is to dilate the sphincters, under an anæsthetic, and with the finger and a Volkmann's spoon to scrape away the polypi as high as can be reached. Tenesmus and rectal discomforts are relieved in this way, but of course the polypi situated in the upper part of the sigmoid flexure and colon are unaffected, so loose motions of mucus and blood continue. The scraping may have to be repeated. There is sharp bleeding which must be arrested by hot injections. Complications sometimes arising from polypus are abscess, ulcer, fissure, and fistula. If with history of polypus none can be felt, the patient must be examined just after an administration of an enema.

Polypoid growths are small growths not absolutely pedunculated protruding from the rectal mucous membrane. They rarely come outside the anus. There are two kinds, both to be distinguished from warts, which chiefly affect the outside of the anus. One kind are little tags of mucous membrane, never more than one inch long, generally situated on a small pile, or at the upper part of a fissure. The other kind are hard and nipple-like, with broad base and firm-pointed apex. They are composed of dense fibrous tissue. Discharge of mucus, or a moist watery condition of the anus, is the symptom for which such growths usually lead patients to consultation. Examination with finger and speculum reveal these growths which are to be removed with the scissors.

Warts around the anus are as warts elsewhere. They are best removed by applying fuming nitric acid to each individually, and scraping them off, applying acid again to their bases.

Pruritus Ani or Painful Itching.—This is a distressing and intractable affection, but is always curable if the patient will patiently and persistently follow out treatment. The general causes are too free living, hereditary predisposition, and various disorders, of which gout is the most frequent. Particular articles of diet affect some persons—lobster, for instance, invariably causing pruritus in certain subjects. Spirits, coffee, and excessive smoking often excite the complaint. Occasionally it must be considered as a pure neurosis. Local causes are constipation, piles, polypi, fistula, and vaginal discharges. The itching is usually worse at night, but in excitable persons often comes on after exercise, or on entering a warm room.

Usually the affected part shows a distinct rash, or is dry, rugose, or bright red. Sometimes there are a number of minute scales forming irregular rings upon it. The most characteristic appearance is loss of the natural pigment of the part. General treatment must be appropriate to the cause, and is of the highest importance. Locally, irritation is best relieved by strong alkaline solutions frequently applied. Light diet, exercise, and mineral waters play a prominent part in the treatment of most cases, and nervous people require sedatives, sometimes in large doses, at bedtime. Opium is to be avoided. Ointments, lotions, and powders may have to be tried, and before their application the part is to be washed with Castile soap, or oatmeal and water. In obstinate, old-standing cases the parts should be rubbed with solution of nitrate of silver, 40 grains to the ounce of water. When the irritation is so great that the sufferer is worn out for want of rest, a bone plug may be inserted into the anus at night. It is shaped like the teat of a feeding-bottle, and has a circular shield to prevent slipping. In some cases, when there is no discoverable cause, benefit accrues from dilating the sphincters.

Fissure and Painful Irritable Ulcer of the Rectum.—This small affection wears out a patient's health and strength in a remarkable manner, if, through motives of delicacy, for instance, it is allowed to go on a long time. Yet it is very easily cured. Ulcer, or fissure, which is only a small ulcer in a particular position, may be caused by constipation, polypi, syphilis, or congenital narrowness of the anal orifice. It is commonly situated along the internal or external sphincter. Ulcers and fissures vary in depth and size. They may be simple wounds, or inflamed, callous, indurated, or even with a sloughy base. The most usual position is dorsal. Usually the patient believes himself to have piles, complaining of discharge of blood and matter, and swelling and pain at stool. The pain at stool may be excruciating, leaving the sufferer to postpone action of the bowels, and thus increasing the pain eventually produced by passage of hard, desiccated fæces. Often pain continues long after a motion, and sometimes does not begin till some minutes after. The great mobility of the external sphincter, and its free and easily exposed nerve-supply, account for the severity of the pain. Retention of urine, pain in the back, and numbness down the legs, may be caused by fissure. Examination for fissure is conducted in the manner described as usually to be adopted for rectal examination. A polypoid growth will often be seen at the upper part of the fissure. A speculum may be needed for detection of an ulcer, though the educated finger distinguishes the spot at once, for it feels like the internal aperture of a fistula, but with harder edges, and without elevation above the level of the mucous membrane. In children and young persons, unless a polypus or polypoid growth is present, cure can be obtained without operation. Rest, mild laxatives, mercurial ointment, and cleanliness, are all that is necessary. After action of the bowels an opiate injection is to be used. If there is great spasm of the sphincter belladonna ointment is to be smeared around the anus over the sphincter. When a fissure is anterior or lateral, it can be cured without operation. When it is dorsal, and there is no spasm or hypertrophy of sphincter, it can also be so cured. When the fissure is dorsal, with spasm or hypertrophy of the sphincter, palliative treatment is not enough. Division, or very free dilatation of the sphincters, is then necessary. The external sphincter must be completely divided, the internal only stretched. The incision should begin a little above the upper end of the fissure, and end a little below the outer end. Its depth should be not less than half an inch. Polypoid growths, and swollen, inflamed skin, if present, are to be removed with scissors. A small piece of cotton wool is placed in the wound for forty-eight hours, and the patient kept in bed till the wound is healed, after-treatment being as with fistula cases. Complete dilatation is effected by pressing and pulling with the thumbs till the sphincters previously hard feel like putty. It takes five minutes to do this thoroughly. All ulcers about the internal sphincter are best treated by incision; old, large, indurated fissures also require this treatment, and those complicated by piles or fistula. Simple fissures about the external sphincter, and those in the old, phthisical, and broken-down in health, and in children, if the operation is necessary, should be cured by dilatation.

Neuralgia and Hysteria of the Rectum.—This term is applied to a painful condition of rectum, when nothing can be found to cause the symptoms. Many slight lesions are easily overlooked, and the absence of these must be certainly ascertained before any case is christened neuralgia or hysteria.

(1) Very slight erosion or inflammation of a spot in the rectum, high up or low down, may cause great pain, and yet be found only with utmost difficulty.

(2) Fissures and irritable ulcers may give rise to nervous sensations, even after they have healed. Perhaps a nerve filament is implicated in the cicatrix. When no local cause is present the symptoms are—

(*a*) Reflex, caused by lesion elsewhere.

(*b*) Actual neuralgia, or hysteria.

These cases do occur, though not commonly. Sufferers from these obscure affections are generally healthy people with no other trouble. They complain of short, stabbing pain, unrelated to action of the bowels, with no apparent cause, and at times very intense. Others have a sense of fulness and burning, unrelieved by purgation or washing out the bowel. Others are frequently obliged to go to stool, where they get no relief, while others are burdened with a constant sense of the presence of the rectum. In such cases, when the most careful examination reveals no local or distant cause for the symptoms, these must be regarded as neuralgic or hysterical. Conditions with which such symptoms are associated are—

(1) Congestion of the rectal vessels.
(2) Uterine, urinary organ, and prostatic disease.
(3) Locomotor ataxy.
(4) Mania.
(5) Epilepsy.

When none of these exist, and there is no local cause, we are confronted with a true neuralgic or else a hysterical rectum. Possibly neuritis of rectal nerves may explain the pain.

Persistent Constipation.—The surgical aspect of this complaint may here be appropriately considered:—

(1) Spasm with hypertrophy of sphincters is not at all an uncommon cause of persistent constipation. It may be first induced by an attack of constipation, which it then itself renders persistent. The original attack may arise in many ways, very commonly from irregularity in attending to action of the bowels. The rectum and colon are over-distended and cannot act forcibly. The fæces become hard and dry, and the muscular tissue of the bowel weakened, perhaps poisoned. Straining with little or no result follows. From this, and the irritation of the fæces, spasm and hypertrophy mainly result. In examining such a case it is found that no dilatation of the anus follows upon the patient's bearing down. On introduction of the finger the sphincters are felt to be tight and broad.

(2) Congenital narrowness of the anal orifice is another important cause of chronic constipation.

(3) The condition may result from atony combined with loss of muscular sense.

(4) The third variety of procidentia may lend to severe constipation.

(5) Malformation of the uterus and enlargement of the prostate may be the cause, or the constipation may be a reflex result of renal calculus.

(6) Irreducible hernia.

Treatment.—As an adjunct to all methods of treatment a copious enema is to be given, a tube should be used not shorter than six inches, with a calibre not less than one-third of an inch, and open at the top. In bad cases a much longer tube is to be employed. To pass this the left forefinger is introduced into the rectum, and the tube slid along it beyond the promontory into the sigmoid flexure. Now inject water, simultaneously pushing the tube up the bowel. As much water is to be injected as can be borne without pain. In such cases forcible dilatation of the anus is often necessary for a cure, or in less severe cases daily passage of bougies in increasing size. For the congenital cases forcible dilatation or division of the sphincters, followed by daily use of bougies, is the only satisfactory treatment. In the old or feeble a systematic course of galvanism, one pole in the rectum, and the other moved about over the surface of the abdomen, is to be recommended. Massage is useful. When the subject of constipation has a lax and pendulous abdomen a suitable belt materially assists in curing the complaint. Glycerine injections are of service only so long as they act as a local irritant. When the rectum becomes accustomed to them they are of no more service than warm water.

Impaction and Concretions.—These may follow a single attack of constipation. Their presence is generally marked by the occurrence of diarrhœa. The cause is nearly always loss of power in the muscular coat of the rectum. The accumulation takes place in the pouch just above the internal sphincter. There is always spasm of the sphincter. The symptoms are obscure, and the malady often misinterpreted. A common error is to treat the patient for diarrhœa with tenesmus. Severe pains may be experienced in the right lumbar and left inguinal regions. Dyspepsia, irritability of temper, nervousness, and despondency, morning vomiting, distaste for food, thirst, and frequent liquid motions without relief, are common symptoms of impaction. On palpating the abdomen tumours may be felt in the transverse colon or sigmoid flexure. The anus is nipple-shaped, and the sphincters are tightly contracted, whilst the finger introduced with difficulty meets a ball of hardened clayey fæces. When the tumour is high up careful palpation proves it to differ in size and shape at different times, and to be irregularly soft with a doughy feeling.

Treatment.—This is begun by thoroughly breaking up the ball of fæces. An anæsthetic is necessary, for the sphincters are to be dilated, and the mass broken up with a lithotomy scoop. Injection of soap and water, oil, and fresh ox-gall will then fetch away enormous quantities of fæces. Care is required that no reaccumulation takes place, as it is a considerable time before the rectum recovers power after great distension.

Concretions in the bowel are rarer than impactions, and when they exist often give rise to the latter. They are usually formed round some foreign body, and are cylindrical in shape. They consist of animal and vegetable fibres matted round a central nucleus, which may be of various material. Concretions must be removed after dilatation of the sphincters under an anæsthetic; they are too tenacious to be broken up like an impaction.

Ulceration of the Rectum.—Ulceration extending above, or entirely situated above the internal sphincter, is not very uncommon. In the early stages it is amenable to treatment, but, unfortunately, this is rarely offered, the symptoms being obscure and insidious, and the suffering at first so slight that the patient deceives himself. The chief varieties are—

(1) Tubercular.
(2) Dysenteric.
(3) Syphilitic.
(4) Traumatic.

In most cases the history alone indicates the nature of the ulceration, and too much reliance must not be placed upon its character to the touch.

Symptoms.—The earliest is morning diarrhœa of a peculiar character. The patient on rising immediately feels urgent desire to go to stool. Wind, a little loose motion, and some discharge are passed. The last resembles "coffee grounds," or is like white of egg, or is more rarely pus. The patient has tenesmus, is not relieved, and before long again has to seek the closet. This time lumpy motions smeared with blood are probably passed. After breakfast probably the bowels act again, and he is then fairly comfortable for the day, only an occasional disagreeable sensation reminding him that there is something wrong with the bowel. Mucus or mucopus may exude from the anus. After some months there is burning pain after an evacuation, and increase in the discharge, which is more largely pus. The pain is induced by walking and standing. Diarrhœa appears now in the evening as well as in the morning, and the health begins to suffer. Anomalous pains are felt in the back, hips, legs, and perhaps penis. Alternating attacks of diarrhœa and constipation may now occur, and the diarrhœa is alternated with severe colicky pain, faintness, or sickness. Attacks of a low form of peritonitis occur. There is tympanitis and tenderness on pressure at one or more spots on the abdomen.

Examining such a case per rectum, the condition found varies according to the stage of the disease. Early, ulcers may be felt within two inches from the anus, with raised hard edge, painful, and readily bleeding. Then there may be lumps, either gummata or enlarged glands. In this stage the disease is often curable. Later there is great thickness of mucous membrane, and outside the anus are swollen tender flaps of skin. So definite is the outside appearance in advanced cases that one glance tells an expert the presence of cancer or severe ulceration. Stricture, and probably fistula, are now present. Perforation into the bladder, vagina, or peritoneum may take place. The patient's state resembles that of a sufferer from malignant disease, and no remedy short of colotomy offers much chance of even temporarily prolonging life. Relief is possible, but cure scarcely.

Palliative Treatment.—Rest in the recumbent position and a fluid diet, consisting mainly of milk, vastly improve these patients. Locally various sedative and astringent ointments are to be used. Dysenteric cases are treated with large doses of pulv. ipecac. co. in addition, and injections of silver nitrate 20-40 grs. to three pints of water. Syphilitic subjects require a thorough course of mercury if seen early. In all bad cases inguinal colotomy is the best means of relief.

Stricture of the Rectum.—All the different kinds of ulceration may result in stricture; ulceration with stricture also results from improper operations upon the rectum. Stricture without ulceration is somewhat uncommon. It may result from chronic inflammation caused by repeated passage of hard, dry fæces. It has been seen after frequent, perhaps rough use of an enema tube. Bruising of the bowel after a long delivery has sometimes appeared to be the cause, and in other cases there is no apparent explanation of the causation of chronic inflammation which seems to have gone on in the wall of the bowel. Rarely in young persons there is congenital narrowness of the lower part of the rectum. Any hard tumour in the pelvis may press upon the rectum and give rise to stricture. The symptoms of stricture are straining and difficulty in discharging the motions, which consist of numerous small, broken pieces. There is rarely pain in the bowel itself, but this may be felt in the penis, perinæum, sacrum, thighs, buttocks, and stomach. Strictures are generally within reach and sight. When not so the rectum must be explored with vulcanite balls of different size mounted on pewter stems.

Treatment.—When ulceration is present this must be treated as described, but the stricture is also to be dealt with. Slight cases are treated with bougies, the passage of which must never be left to the patient, as deaths have occurred from passing the instrument through the wall of the bowel. Occasionally, the stricture being within two inches of the anus, a short vulcanite tube may be worn at night. Annular strictures near the anus should be divided in a few places with the knife, treatment with tubes following. The incisions go through the induration, reaching, but not dividing, the healthy tissue beneath. Well-oiled wool is inserted for twenty-four hours, and then the tube introduced and worn, except when the bowels act or the rectum is washed out. Strictures are very apt to return. Patients must be warned never to go long without having a bougie passed. In cases of bad ulceration, stricture, and fistula, linear rectotomy is the only treatment of use. The stricture is divided with the knife from its upper edge down to the coccyx, and through its entire depth. A finger is passed through the stricture, and a long, straight knife along the finger. If the incision is kept in the middle line bleeding is trifling only. The wound is to be well syringed and the parts kept perfectly clean. Dry absorbent wool is the best dressing. When incurable nothing affords relief to these cases except colotomy. For all questions concerning this operation see "Colotomy," vol. ii. To sum up the treatment of strictures of the rectum:—

(1) Simple strictures are treated by gradual dilatations with bougies; if they are very resilient incisions must be made through the strictures.

(2) Strictures complicated by ulceration may be first treated by bougies, but this failing, linear rectotomy is to be employed.

(3) Severe cases continued with fistula and ulceration require colotomy if linear rectotomy fails to cure.

Half the cases of stricture with ulceration are syphilitic. If tertiary they are incurable. Thoroughly treated with drugs, scraping, etc., in an earlier stage, a favourable result may be procured. The next in order of frequency are the dysenteric, and lastly the tubercular. When the tubercle is local only, good results from inguinal colotomy and treatment of the ulceration. The traumatic cases are generally curable by the means above described.

It is often stated that according to the position and character of ulceration the nature of the disease can be diagnosed. Really, all diseases causing stricture and ulceration may affect any part of the rectum, and the only rules that may be formulated, and they are often broken, are these:—

(1) In syphilitic cases there is ulceration and stricture, a good deal of stricture being present with the ulceration.

(2) In dysenteric cases there is much ulceration, with some tendency to stricture.

(3) In tubercular cases there is much ulceration, rarely with stricture.

(4) In traumatic cases there may be stricture with little or no ulceration. On the other hand, there may be ulceration with no stricture.

Complete excision of stricture of the rectum has been practised. We consider the operation unjustifiable.

Cancer of the Rectum.—The causation of this disease is unknown, and the part which heredity plays is matter of dispute. Middle age is the commonest time of life for its appearance, but the very old may be affected, and we have seen it at thirteen years of age. More men than women are attacked.

Columnar-celled carcinoma is the common and typical form. Sarcomata do occur, and epithelioma is found at the anal margin. Scirrhus, encephaloid, and colloid are the varying conditions of carcinoma. Carcinoma of the rectum is—

(1) Laminar, the wall of the bowel being thickened between its mucous and muscular coats by growths spreading laterally.

(2) Tuberous, the growth projecting into the bowel.

(3) Annular, the growth commencing between the muscular and mucous coats, and spreading round the entire circumference of the rectum.

Cancer of the rectum feels sometimes as though it had a pedicle. This is because it drags upon the mucous membrane. At other times it feels like an ulcer surrounded by nodular, irregular edges, or, high up in the bowel, it may be felt as a hard growth, fixed or movable, combined with ulceration, and more or less completely embracing the circumference of the tube.

Symptoms.—There are some signs which are practically certain indications of cancer. The peculiar odour of the discharge cannot be mistaken by the experienced, and the continuous pain and the feel of the growths are unlike those caused by other rectal disorders. The waxen aspect of face occurs earlier in malignant disease of the rectum than with cancer elsewhere, but in some patients the appearance of vigorous health lasts till the disease is far advanced.

Treatment.—In considering the proper treatment to be adopted for these cases, which generally means settling the question between excision of rectum, colotomy, and no operation at all, the chief points of guidance are—

(1) Age of the patient.
(2) Position and extent of growth.
(3) Nature of symptoms, viz. obstruction of bowels, hæmorrhage, or pain.

If the patient's age is not over forty-five excision is very rarely of advantage. The disease almost always returns in such subjects, even before the wounds are healed, and it is in only very exceptional instances that, on repeatedly removing recurrences, the disease at last ceases to appear. Colotomy prolongs life for a very short period in this class of case, and palliative treatment is generally the proper course. In persons between forty-five and sixty years of age excision is most favourable, and should be attempted when the growth is well within the lower part of the rectum. If it is high colotomy must be performed, but not until obstructive symptoms are marked and unrelieved by medicine.

For patients above sixty excision is very suitable in cases where there is a fair chance of removing the whole growth. Colotomy is to be employed under the conditions just mentioned. As regards position the growth may be—

(1) Near the anus, healthy mucous membrane being felt above it.
(2) Higher up, but easily felt and moved, although its upper limit is not readily definable.
(3) At the junction with the sigmoid, only just palpable by the finger.

In the first case the growth should be freely excised, in the second Kraske's operation performed, if the patient agrees on understanding its nature and risks, and in the third colotomy is to be done when the symptoms warrant it. We do not believe that rapidity of growth is lessened by a colotomy which diverts fæces from the cancer; many persons by judicious palliative treatment have had life as long prolonged as by an early colotomy. When, however, obstruction is once marked colotomy should not be delayed, and the operation may be needed to check constant spurious diarrhœa, pain, and hæmorrhage. Palliative treatment is employed in cases where excision is out of the question and colotomy not yet required. Rest, easily digested nourishing diet, alcohol, and sedatives are its chief features. Mild operative measures, as division of the sphincters, or scraping away growth with a scoop, are sometimes of assistance. They are used, of course, only as palliative measures, excision and colotomy being the only effectual methods of removing the pain from cancer of the rectum.

Excision of the Rectum.—The operation is not desirable—

(1) If adhesions exist between the growth and the sacrum, base of bladder, prostate, or cervix uteri.
(2) If enlarged glands are present in inguinal or lumbar regions.
(3) If the patient is already so exhausted by the disease that the necessary loss of blood is a serious risk.

Excision of the rectum is on the whole an operation with very unfavourable prognosis, yet when the patient is seen early enough to make entire removal seem possible, he should be given the chance.

Kraske's method should always be adopted, except when the growth is at the anus, or limited to the neighbourhood of the sphincters; then the perineal operation is advisable. An incision is made in the mid line of the sacrum, beginning at the second vertebra and reaching the anus. The soft parts are divided to the bone and stripped off sacrum and coccyx. The latter is dissected out, and if more room is needed, the lower part of the former cut away with bone forceps. The posterior surface of the rectum is carefully separated, and with the finger its lateral and anterior surfaces also freed. If there is difficulty the bowel should be cut across before it is separated anteriorly. If the disease is low the circumferential cut is made above it, otherwise below it. The division is made with scissors, and vessels are clipped as they are cut. The growth is then cut away and the divided bowel thus dealt with—

(1) The upper end is fixed into the upper angle of the wound, or
(2) An end to end junction of intestinal and anal portions made, or
(3) The upper end is brought down and fixed to the anus.

The first method is usually most suitable. If the peritoneum is opened on removing the growth it is to be closed with silk or catgut sutures.

The perineal operation is only performed when the disease is limited to neighbourhood of sphincters and anus. A deep dorsal incision is the key to the operation. In operating on the male, a silver catheter is to be passed into the bladder and held hooked up under the pubic arch by an assistant. The lithotomy position must be used. On the finger pass a bistoury into the rectum as far as the upper limit of the growth, and make it cut right down on to the sacrum and tip of coccyx. We modify this usual procedure by piercing the skin a little below the anus with a sharp-pointed bistoury, which is made to travel entirely outside the rectum in the cellular tissue up to the top of the growth. Then cut down to the sacrum and press in a sponge to arrest bleeding. Now with a scalpel cut deeply round the anus. Then, with finger in the rectum and thumb in the cut, one blade of a long, blunt-pointed pair of scissors is pushed into the posterior cut, and the other into the cellular tissue of the ischio-rectal-fossa. The cellular tissue between the blades is cut through, and the proceeding repeated on the other side. Sponges are put into the incisions on each side, and the outer parts separated from the bowel by broad retractors. We next turn to the perineal part. The rectum is separated by scissors from the tissues around to one inch above the growth. The scissors being kept against the thumb nail, and the finger still inside the bowel, there is no risk of cutting into urethra, bladder, or rectum. The sponges are now taken out, and two large pairs of pressure forceps applied, one to each side of the freed gut. Some short ligatures are tied tightly beyond the clips as these are slowly loosened, and the rectum divided distally. The rectum may be easily removed in this way in ten minutes. A strip of wool is passed along the finger into the bowel, the cavity from which the rectum was removed is stuffed with antiseptic wool, and a T-bandage is tightly applied. In women the assistant's finger should be in the vagina to ensure against the surgeon cutting too near to its mucous membrane. There is little bleeding if the operation is quickly done, and not dividing the bowel when making the dorsal incision ensures greater speed, for the finger in the gut and the thumb outside make rapid cutting safe and easy. The wool is to be removed day by day, that in the bowel being taken out not later than the fourth day. On this day castor oil is given, and the bowels then kept acting every other day. Later, till the parts are healed, a finger or bougie is passed daily. When all is healed a bougie is passed once a week for several months. Whenever it is possible we leave, at the operation, a healthy strip of mucous membrane. Excision of the rectum has sometimes to be combined with colotomy. Sometimes colotomy is needed after excision, because the rectum during healing shows a tendency to troublesome contraction; in other cases the colotomy has been done first to permit of freer subsequent excision.

After complete excision, unless Kraske's method is completed in the second and third ways mentioned, there is incontinence of flatus and fæces. After partial excision there is no more loss of power than after operation for severe fistula. The operation of colotomy is not here described, as full details are given in the author's article on that subject.

Lupoid and Rodent Ulceration of Anus and Rectum.—Lupoid ulcer of the rectum differs from the same malady on the face by being terribly painful and much less curable. The disease is happily uncommon. In its early stages lupoid ulcer resembles a syphilitic sore or a rodent ulcer. It is distinguished from syphilitic and epitheliomatous affections by these peculiarities:—

(1) It does not invade neighbouring organs, contaminate lymphatics, produce hardness, nor form secondary deposits.

(2) It does not lead to stricture of the rectum, or any submucous thickening. Its shape is irregular, neither edge nor base is at all hard, and the mucous membrane around is abruptly healthy. It destroys completely as far as it extends, and it tends to spread superficially, and upon mucous membrane rather than upon skin. It often remains stationary, or repair may even proceed rapidly only to be suddenly and rapidly replaced by the original condition. The subjects of lupoid ulcer are almost always tuberculous, and phthisis is generally the cause of death. Tubercle bacilli have been found in the ulcer. The sore is to be thoroughly scraped away with Volkmann's spoon, but benefit is only temporary. Colotomy has been followed by great improvement in the condition of the ulcer.

Rodent Ulcer.—Sufferers from this complaint are rarely under fifty years of age, and usually look ruddy and well. The ulcer resembles that last described, except for its hard, well-defined edges and hard base. The surface is generally red and dry. Free excision is the only useful treatment.

Villous Tumour of the Rectum.—This is a rare disease. The growth is just similar to that of the same name found in the bladder. It is attached to the bowel by a broad base, and the peduncle may be as long as three inches. Usually the appearance of having a pedicle is due to the tumour weighing down the mucous membrane. Generally the tumour springs from the posterior wall. The symptoms are:—

(1) Descent of a tumour on the bowels acting, or even merely on walking.

(2) Discharge of glairy mucus.

(3) Hæmorrhage.

The patient is usually of advanced years. In some cases epithelioma has replaced the removed growth. The growths are sometimes spontaneously shed. They may attain to a large size.

Coccygeal Pain.—Severe pain in female patients is sometimes due to tubercular or rheumatoid arthritic disease of the sacro-coccygeal joint, or to osteitis of the coccyx itself. In other cases it is owing to adhesion in the joint following injury. The cases are intractable, and sometimes only cured by removal of the coccyx.

Proctitis occurs in a chronic and an acute form. The former appears in old people, with the symptoms of heat and fulness in the rectum, frequent desire to go to stool, and great tenesmus; there may be, too, discharge of blood and mucus. Sedative and astringent injections give relief.

Acute inflammation of the rectum resembles dysentery, but lacks the abdominal pain, and tenderness, and the constitutional disturbance. The bladder is affected, and there is difficulty in passing water. Leeches around the anus, hot baths, and injections of small amounts of water as hot as can be borne are effective treatment. No purges should be given. Light, unstimulating diet, and the recumbent posture are to be instituted.

Rare Growths.—Dermoid cysts, angiomata, and lipomata of the rectum are surgical curiosities of such rarity that they do not here demand attention.

Reflexes. *See* Spinal Cord.

Refraction.

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Refraction is the name given to the change of direction from their former course of what are conventionally termed[1] "rays of light" when they pass obliquely from one medium into another of different density. It is accounted for by the altered velocity of light in the second medium. In water, for example, light travels at three-fourths, and in glass at two-thirds of its speed in air. The "optical density" of various substances, by which we mean their power of retarding light, varies pretty closely with their physical densities, as if retardation of light depended on the quantity of matter contained in a given space. When light falls on a plane surface bounding two media, as, *e.g.* when it passes out of air into plane glass, the perpendicular ray (Oa in Fig. 1) is undeflected, but all other rays fall obliquely, and are deflected towards the perpendicular ray, as if they came from a point O′ farther away from the glass. This point O′ is called the *virtual image* of O, because to an eye situated in the substance of the glass, as illustrated in the figure, O would appear to be at O′. The distance Oa is to the distance O′a as the speed of light in glass is to its speed in air, namely, as two to three. To find the expression for the optical density of a substance we have to invert this fraction, for the speed of light varies inversely with the density of the substance through which it passes. The fraction thus inverted is called the "index of refraction" for that substance, and is represented by the letter μ. In the case of glass μ is but slightly over 1·5.[2]

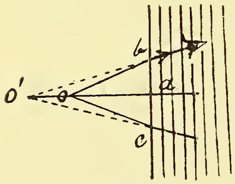

Fig. 1.

When light travels out of a denser into a rarer medium, as out of glass into air (Fig. 2), the obliquely incident rays are bent away from the perpendicular, as if they came from a point called the "virtual focus," whose distance from the surface is two-thirds that of the real focus.

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[1] Rays of light are merely the *directions* in which light travels, being perpendiculars to the wave-fronts, and have no concrete existence, but this is not the place to enter into physical optics.

[2] The term density-constant might be suggested as a better one than "index of refraction," if Sylvanus Thompson's term of *velocity-constant* be adopted for the retardation of light, and

To an eye in air, therefore, as illustrated in the diagram, the point O appears to be at O′.

Plane Glass.—When light passes through a sheet of plane glass the refractions at the two surfaces, being respectively incident and emergent, and thus of opposite kinds, neutralise each other, so that the rays emerge parallel to their previous course before incidence.

Prisms.—When two plane faces of a transparent body are inclined to one another they enclose an "optical prism." A ray of light (*i* in Fig. 3) falling on one face is deflected towards the normal (*n*), and on emerging from the second face is deflected from the normal (*n′*), so that the angle of total deflection lies between the incident ray (*i*) and the emergent ray produced backwards (*r′*). It will be seen from the figure that prisms deflect light towards their bases, and appear to displace objects towards their apices. Thus to an eye at E, the object O appears displaced to O′ by an angle which is called the *angle of deviation.*

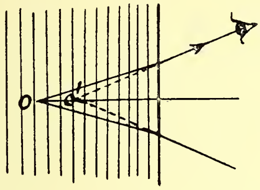

Fig. 2.

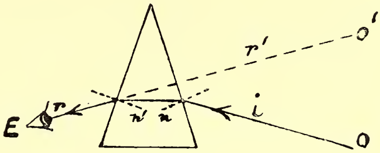

Fig. 3.

When the material of the prism is glass, and provided also that the prism be a fairly weak one, and be so held that the light does not traverse it too obliquely, the angle of deviation is about half the angle between the two faces. A prism deflects light least (or, in other words, is held in the "position of mimimum deviation") when the incident and emergent rays are symmetrically inclined to its surface. The actual angle between the faces was that by which prisms used to be marked, and frequently are still. A suggestion[1] to measure prisms by the deviating angle instead of the material angle was published in 1886, since it is their optical properties, and not their physical conformations, that make them of value, and an easy method of so doing was placed by the writer in the hands of Messrs. Curry and Paxton. Jackson, independently and more publicly, proposed at a later date that all prisms should be *numerated* by their deviating angles. To distinguish this notation from the old one, it was agreed by a committee of the U.S.A. Ophthalmic Society that the letter *d* should be appended. Thus a prism of 3° *d* is the same as a 6° prism of the old marking; though it deflects light by 3°, the angle between its faces is 6°.

Lenses differ from prisms in that they have curved surfaces. They are divided into two classes, *spherical* and *cylindrical.* The former may be bi-convex (*a*, Fig. 4), bi-concave (*b*), plano-convex (*c*), plano-concave (*d*), convex menisci (*e*), or concave menisci (*f*). Every lens has an unchangeable optical strength peculiar to itself, and corresponding therewith a definite focal length, these two quantities being reciprocally related to each

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since one of these constants is always the reciprocal of the other for any given substance, there is peculiar appropriateness in his selection of the letter h for the velocity-constant, for h inverted closely resembles μ.

[1] Syme Surgical Fellowship Essay, Edinburgh University (1884), published 1886.

other, for the shorter the focal length the greater the optical strength. It is necessary, therefore, to explain what is meant by the focal length. A convex lens interposed in the path of a parallel beam of light brings the light to a focus at a constant distance from itself, which is called the "focal length of the lens" (Fig. 5). The stronger the lens the shorter its focal length, so that if we let F stand for the optical strength, and f for the focal length, $F = \frac{1}{f}$. Ophthalmologists used formerly to measure f in inches, but now in metres, since the accepted unit of optical strength is that possessed by a lens of one metre focal length. This accepted unit of optical power is called a *dioptre.* Two lenses each possessed of one dioptre of refractive power placed in close apposition would form a combination having twice the refractive power of either one alone; hence the focal length of the combination would be half as much, *i.e.* half a metre. Three such apposed lenses would have an optical power three times as great, and therefore a focal length three times as short or one-third of a metre; and so on. In fact we have only to imagine ourselves possessed of a metre rod with no markings on it, and nothing else to measure with, to understand the dioptric system. This rod will be about 40 inches long. How many dioptres has any given lens? Just as many as the times its focal length is measurable into the metre-rod, or, in other words, as many as the times its focal length in inches will go into 40 inches. Take, *e.g.* a lens of 10 inches focal length, it will measure four times into the rod, and therefore be of four dioptres. This lens is written down as + 4D, the plus sign being allotted to convex lenses. To concave lenses, on the other hand, the minus sign is prefixed. The latter have no *real* focus, but only a *virtual* one, for when placed in a beam of light they make it spread out as if coming from the virtual focus P' (Fig. 6). It will be seen that the virtual focus of a concave lens lies on the incident side of the lens. It is for this reason the focal length (f) is reckoned negative.

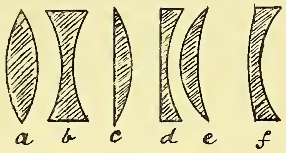

FIG. 4.

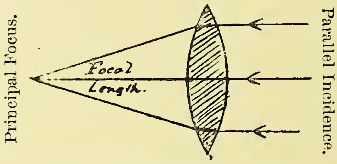

FIG. 5.—A collecting lens: focal length *positive.*

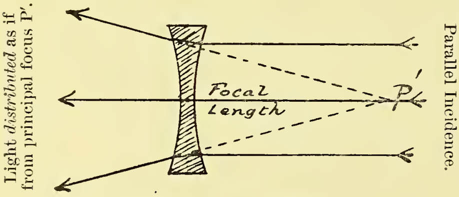

FIG. 6.—A distributing lens: focal length *negative.*

Conjugate Foci.—When divergent rays, such as proceed from a source at a finite distance, fall upon a convex lens, part of the converging power of the lens is taken up in overcoming the divergency of the incident light, leaving only the remainder to converge the emergent light. But lessened convergence of the emergent light means greater distance of its focus from the lens. Hence, though the lens is just as strong as the lens in Fig. 5, the focus lies farther from the lens than the principal focus in Fig. 5. In such case the focus of origin and the focus of destination are called "conjugate foci," because they are so yoked together that when one is made to approach the lens the other recedes from it. The reason of this is very simple,—the more the point of origin approaches the lens the greater is the divergence of the incident light, and the greater proportion, therefore, of the power of the lens is used up to overcome that divergency, leaving only the residuum of power to effect the convergence of the emergent light.

To give an example, let us suppose the lens in question to possess four units (dioptres) of converging power. That means that it converges parallel light to a focus a quarter of a metre away from itself. Let us replace the incident beam of parallel light by one of divergent light from a point half a metre away. Such incident light arrives at the lens with a divergency of two dioptres. It therefore appropriates two dioptres of power from the lens to overcome its incident divergency, leaving two others to effect the convergency of the emergent light. Since the power of the lens is in this instance divided into two equal parts, it is evident that the two foci (of origin and destination) will be equidistant from the lens, and that each will lie twice as far from it as the principal focus. Had the lens been one of 5D instead of 4D, it would retain 3D of converging power, since 2D from 5D leaves 3D, and the conjugate focus of the emergent light would be found one-third of a metre away from the lens. This is illustrated in the figure.

If, on the other hand, the incident light be made to fall in an already converging condition upon the same lens, the whole power of the lens is available to *add* to the already existing convergency. Thus light with 3D of convergency, incident on a + 5D lens, would, *but* for the interposition of the lens, have been collected to a focus a third of a metre farther on. When a lens is interposed, however, though the incident light is still directed towards that focus, it becomes a virtual focus, since the light does not really arrive there, being gathered up by the lens to a real focus at a nearer point. If the lens be one of + 5D, it adds the whole of its 5D to the 3D already possessed by the incident beam, so the light leaves it with a convergency of 8D. The conjugate focus, therefore, will be $\frac{1}{8}$ metre from the lens, for we still call them conjugate foci, though one is virtual and the other real. They both lie on the same side of the lens, and the nearer one is brought to the lens the nearer comes the other. It has been observed that conjugate foci, of whatever kind, always move in the same direction.

Images.—So far we have supposed the incident light to proceed from a point. But in nature luminous points do not exist except in groups. The surface of any object may be regarded as composed of an indefinite number of points side by side; and since, when a lens is brought into play, each has its conjugate focus, or point-image, all of these also lie side by side, so as to form a corresponding group, or *image* of the object, which may, however, be real or virtual, just as we have already considered. The relative size of image and object follows the very simple rule that it is directly proportionate to the distance of each from the lens.

When an image lies on the opposite side of a lens from the object, it is always *inverted;* when on the same side it is always erect.

Cylindrical lenses differ from spherical in that they are curved in one direction only, but like them they are divided into two classes of convex and concave. The shape of a convex cylinder is as though a small circular piece were sliced off the surface of a column or solid cylinder of glass. One meridian of the lens, therefore, answering to the long axis of the column, has no refracting power, and is called the "axis" of the lens. The meridian at right angles to the axis has the maximum refracting power, and is that by which the cylinder is numerated. Thus a cylinder having its maximum curvature equal to the all-round curvature of a + 1D spherical lens, is a + 1D Cyl. Its focal length is 1 metre, but the light is focussed into a line instead of into a point.

The extremities of the axis are usually denoted by tiny scratches in the glass, but they might with advantage be further indicated by two notches in the metal rim of the lens, so as to utilise the surgeon's sense of touch, according to a suggestion made to the writer by Anderson Stuart. It is customary also for good cylindrical lenses to have two opposite areas obscured like "ground glass," having their edges parallel to the axis of the lens.

Measurement of Lenses.—Concave lenses not only have the property of making objects viewed through them appear smaller, but when the lens is moved from side to side an apparent motion is imparted to any object viewed through the lens in the same direction as the movement of the lens (see Fig. 7). The farther the lens is held from the eye the greater is the apparent motion. The strength of the lens is best determined by the process of " neutralisation, *i.e.* by finding which of the convex lenses from the trial-case abolishes this apparent motion and makes the combination resemble a piece of plane glass. For weak lenses this method is very exact, and for strong lenses it is exact enough for practical purposes. When, however, strong lenses of equal power and opposite sign are apposed, the combination exhibits an appreciable "convex" character of motion, whichever lens be held nearer the eye. This fact, which many have noticed from the trial-case and puzzled over, I have graphically explained by Fig. 8, which shows how the two outside surfaces of the combination would, if continued in space, as shown by the dotted lines, form a convex meniscus.

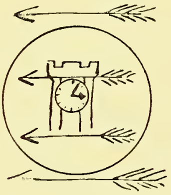

Fig. 7.—Apparent motion through a concave lens.

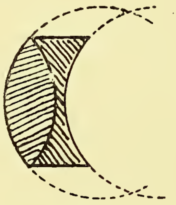

Fig. 8.

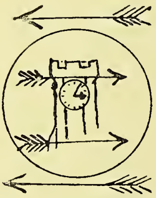

Fig. 9.—Apparent motion through a convex lens.

A convex lens not only makes distant objects appear dim to an emmetropic eye and near objects appear magnified, but when displaced laterally it makes objects appear to move in the opposite direction, *i.e.* *against* its own motion (Fig. 9). This motion can be neutralised, and the lens measured by the apposition of the concave lens of equal strength from the trial-case. An excellent alternative mode of measuring lenses is afforded by the now well-known Geneva lens measure (Fig. 10), which, when pressed against each surface of the lens in turn, tells the dioptric power of each surface. The two readings must, of course, be added together to give the strength of the lens. For pebble lenses the findings of this instrument are a little too low. The index of refraction being higher for pebble, the same curvature betokens a greater refractive power.

Measurement of Cylinders.—The first step is to find the axis, by looking through the lens at a (preferably distant) vertical line and rotating it till the part of the line viewed through the cylinder no longer appears "tilted," but continuous, above and below, with the rest of the line. If now the lens can be moved in a direction parallel to the length of the line, without causing any apparent displacement of neighbouring objects, the axis of the lens is parallel to the line. If, on the other hand, it imparts apparent motion to the neighbouring objects when it is moved along the direction of the line, the axis is perpendicular to the line, as confirmed by the apparent immobility of objects when the lens is moved at right angles to the same. In either case the lens is convex or concave, according as the objects appear to move "against" or "with" its own motion. Having found the axis and character of the lens, it is easy to appose successive cylinders of opposite sign from the trial-case, axis to axis ever, till all apparent motion is neutralised. Another plan is to appose spherical lenses till one is found which annuls all motion along a meridian perpendicular to the axis, since this is the meridian of maximum curvature.

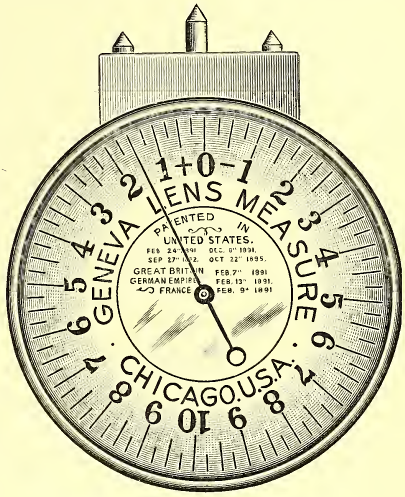

Fig. 10.—Geneva Lens Measure.

References have already been made to the Geneva lens measure. If pressed against a cylindrical lens, its index-hand points to zero when its three teeth lie along the axis of the lens, but on rotating the apparatus slowly the index rises gradually till the maximum reading is reached at right angles to the axis, demonstrating very prettily the gradual increase of curvature of successive meridians as they become more and more distant from the axis. In the case of strongly cylindrical spectacle-lenses, the exact inclination of the axis is a matter of considerable importance, and though it may be guessed to a very close approximation by the methods already described, greater accuracy is afforded by the writer's "axis-finder," which tells the axis not merely in relation to the long diameter of the lens, but to the long diameter of the spectacle frame as a whole, as it sits upon the face, which is, of course, what we want to know (see Fig. 11).

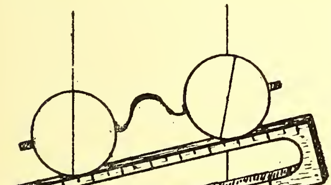

Fig. 11.—Writer's Axis-Finder.

Emmetropia is the optical condition of the natural eye, in which, during negative accommodation, the length of the eyeball and the focal length of the dioptric media are so proportioned that the retina lies at the principal focus; or, in other words, the conjugate focus of the retina lies at infinity. This enables the retina to receive clear images of very distant objects, and, when the ciliary muscle is paralysed, of them only. With an active ciliary muscle each increment of accommodation causes the conjugate focus of the retina to approach the eye, till eventually it reaches the "near point" or "punctum proximum."

All investigators are agreed that accommodation is brought about by a change in the shape of the crystalline lens effected by contraction of the ciliary muscle, though two rival theories (Helmholtz, Tscherning) are in the field as to the nature of the change, the former having maintained that it is caused by relaxation, and the latter by tightening, of the zonule. It is readily seen that while an emmetropic eye has the power of accommodating itself to receive the diverging rays which proceed from near objects, the utmost it can do by extreme relaxation is to focus parallel rays on its retina. The smallest convergence possessed by an entering pencil is incompatible with distinct retinal pictures. That is why an even weak convex (*i.e.* converging) lens held before an emmetropic eye impairs the definition of distant objects, a phenomenon which supplies us with one of the three tests necessary to prove an eye emmetropic. Since it only excludes hypermetropia, a second test is needed to exclude myopia, and consists in demonstrating that either there exists full acuity of distant vision, or that at any rate there is no marked improvement of vision (other than accounted for by slight contraction of the pupil) by a weak concave lens. Though the second test excludes high astigmatism, yet a third is necessary to guard against the presence of a low degree of that defect, and may be instituted either by noting the effect of weak cylindrical lenses or by directing the patient's attention to lines running in different directions, as described farther on.

Actually, very few eyes are strictly emmetropic, a trace of astigmatism being almost universal, owing to the vertical meridian of the cornea being more strongly curved than the horizontal. While any distant object may be chosen for the first of the two tests, the most convenient in practice are Snellen's test-types (consult articles on "Visual Acuity") at a distance of 6 metres (20 feet).

Range of Accommodation.—In emmetropia the "far point" remains at infinity, but the "near point" gradually recedes from the eye as age advances, curtailing the range of accommodation year by year. The near point is best discovered by approaching Jaeger's small test-types (described in the article on "Visual Acuity") first to both eyes together (binocular), then to each singly (monocular), till the greatest nearness compatible with distinct vision is reached. This distance, measured from the eye in centimetres and divided into 100, gives the range of accommodation in dioptres. Thus a patient who ceases to see J_1 (see article on "Visual Acuity") quite distinctly if held nearer than 8 cm. to his eyes, has $\frac{100}{8} = 12\frac{1}{2}$D of accommodation power, while another, whose power of distinct vision fails at 25 cm. has $\frac{100}{25} = 4$D of accommodation power. Dioptric tapes are sold which make even this simple calculation unnecessary. Those who prefer to take measurements in inches should divide into 40 instead of into 100, and the result will come out the same. Thus, with a near point of 5 inches, the range of accommodation is $\frac{40}{5} = 8$D. In later life a normal eye acquires slight hypermetropia.

The following table shows the range of accommodation at different ages, and is taken principally from Donders. The acquired hypermetropia appears to the writer slightly exaggerated:—

Age.	Near Point in Inches.	Near Point in Centimetres.	Range of Accommodation.	Acquired Hypermetropia.
	″	cm.	D.	D.
10	2¾	7	14	
15	3¼	8	12	
20	4	10	10	
25	4¾	12	8·5	
30	5¾	14	7	
35	7¼	18	5·5	
40	9	22	4·5	
45	11½	28	3·5	
50	16	40	2·5	
55	26	66	1·75	0·25
60	80	200	1	0·5
65	∞	∞	0·75	0·75
70	– 40	– 100[1]	0·25	1·25
75	– 23	– 57	0	1·75
80	– 16	– 40	0	2·5

HYPERMETROPIA is generally the expression of imperfect development of the eyeball, which resembles those of the lower animals in being more flattened from before backwards. Thus results a discrepancy between the length of the eyeball and the focal length of its media, the former being less than the latter. When the accommodating power of the eye is able to shorten the focal length sufficiently to make it coincide with the eyeball length, the defect of focus is for the time overcome. Hypermetropia of this kind is called "Facultative," in contrast to "Absolute" hypermetropia, in which all such efforts fall short of their mark. Moreover, all young hypermetropes, and many middle-aged ones, have a certain fraction of their defect (which becomes smaller every year) constantly masked by an involuntary residuum of accommodative action which remains in force even when the voluntary relaxation of accommodation is tempted to the utmost by convex lenses. This perpetually neutralised fraction of the refractive error is called the "Latent H," while the remainder is called the "Manifest H," since it can be manifested by the toleration of convex lenses. The two together constitute the "Total H." To learn the "Latent H," we must first measure the "Manifest H," then paralyse the ciliary muscle by some cycloplegic like atropine, and measure the "Total H." The difference between the two gives the "Latent H." To detect H we may employ retinoscopy (*q.v.*), or subjective tests. For the latter it is customary to place the patient 5 or 6 metres from Snellen's distant test-types, and find, with each eye separately, what is the *strongest* convex lens compatible with the best vision obtainable. If, after thus testing each eye separately, the two lenses found be left in the trial frame, while, with both eyes open, weak pairs of sphericals are placed simultaneously before the two eyes, it will often be found that more hypermetropia becomes manifest binocularly than monocularly, and this procedure should never be omitted in correcting any error of refraction. Before turning to the treatment of H, it is well to consider that nature treats it by hypertrophy of the ciliary muscle (analogous to compensatory hypertrophy of the heart). So long as compensation is sufficient and no discomfort exists, it is wise to let nature develop her own resources, and to refrain from what we might almost call meddlesome spectacling. It is chiefly in strong, healthy young people that such compensation exists. There is, however, a larger class in these hyper-educational days whose neuro-muscular energy is insufficient, and in whom the lack of compensatory power makes itself felt by headaches, eye-strain, and various sensory discomforts, while at times the page becomes misty, as the tired muscles "give out." Even in such cases we should not always think of correcting the total hypermetropia. We should help nature rather than supplant her. In some cases, especially among young people, it suffices to correct the manifest hypermetropia alone; in a larger number half the latent element should also be corrected, while in a certain proportion, and I think in all adults, and most certainly in every case of convergent squint, it is advisable to correct the whole. We should also be guided often by the muscular balance of the eyeballs.

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[1] The minus sign is prefixed to show that the near point has become virtual, *i.e.* behind the eye instead of before it.

If, while looking at a distant object, a condition of latent convergence can be demonstrated, a more complete correction of the total hypermetropia is indicated.

If, on the other hand, latent divergence be great, convex glasses would increase it by lessening the accommodative effort, and with it the associated convergence, and should therefore be prescribed as weak as possible. The balance is conveniently tested by placing a lighted candle, or other small source of light, at a distance of 5 metres from the patient, while a disc of horizontal glass rods[1] is held before one eye so as to make the flame appear drawn out into a long streak of light, while the naked eye, of course, sees the flame as it is. Homonymous diplopia, in which the streak appears on the same side as the rods producing it, indicates convergence, while crossed diplopia indicates divergence.

The slight hypermetropia incidental to diabetes is attributed, with good reason, to an increased index of refraction of the vitreous body. Increased index of the aqueous, on the other hand, tends to myopia. Nearly all young children are hypermetropic, and there is reason to believe that it gradually lessens with development of the eye. After about the age of fifty-three, however, another kind of H (H acquisita) begins to appear, and goes on increasing, as shown in the last column of the table given in the section on emmetropia. Priestley Smith ascribes it, with some reason, to the steady growth of the lens which he has so beautifully demonstrated, but it is also rational to expect that the eyeball should share the senile shrinking of the whole body, and thus its antero-posterior diameter becomes less (Donders).

Since in hypermetropes part of the accommodative power is spent in correcting the refractive defect, the range of accommodation is shortened in proportion, and the near point lies farther from the eye. A natural consequence of this is that presbyopia sets in earlier.

Hypermetropic patients are apt to have the curious habit of finding relief by pressing the inner canthi with their forefingers. It only remains to add that ocular headaches, hyperæmia of the lids, and sometimes even blepharitis, are kept up by hypermetropia.

Myopia exists whenever the antero-posterior axis of the eyeball is too long for the focal length of the eye. Pencils of light must enter the eye divergent if they are to be focussed on the retina of a myopic eye. Compare what is said about Fig. 7. There are, optically considered, four kinds of myopia—

(*a*) From abnormal suspension of the lens.
(*b*) From densification of nucleus.

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[1] The disc of rods is obtainable from Messrs. Curry and Paxton, 195 Gt. Portland Street, together with scales for placing behind the flame in order to measure the deviation in degrees.

(*c*) From the shape of the cornea.
(*d*) From elongation of the globe.

The first is well known as a transitory consequence of a blow on the eye, and is then termed traumatic myopia. Probably the suspensory ligament is stretched by the blow, and allows the lens to come forward a little until its elasticity is re-established. It may also allow the anterior surface of the lens to assume an abnormal rotundity.

Possibly a similar myopia may exist from defective development of the zonule apart from traumatism.

The second is frequently met with up to 3 or 4 D, or sometimes much higher, in the early stages of nuclear cataract.

The third is the least considerable class, and is discovered when the ophthalmometer shows the cornea to be strongly curved. Care should be taken not to overlook a low degree of conical cornea.

The fourth kind of myopia is by far the commonest. In low degree it sometimes occurs in a purely developmental form, the eye being simply larger than usual in all its dimensions. Happily in these cases the liquid pressure within the eye (which is generally about that of an inch of mercury) is less than usual. Were it not so the short sight would be almost certain to increase, in virtue of the simple hydrostatic law, to be remembered in this connection, that for a given pressure per unit area the strain on the coats is proportionate to the number of unit areas exposed to the pressure. It is very likely that some of the myopias which are assumed to be developmental because of the uniform enlargement of the eye are also really stretched eyes, for a study of hydrophthalmos and infantile glaucoma shows that the eyes of children are more distensible in all diameters, whereas those of (at any rate myopically predisposed) adults are more distensible at the posterior pole. One reason for this is, that the more careful and prolonged inspection of near objects, which comes with growing years, requires greater action of the extra-ocular muscles, which support the globe everywhere except at the posterior pole, where the muscular cone leaves it to be supported only by retrobulbar fat.

Unlike hypermetropia, myopia is the rarest thing in infancy, and generally does not show itself till between eight and twelve years of age. The educational period of life from twelve to eighteen is the most dangerous for its increase, since it requires prolonged convergence of the eyes upon near objects, with more or less stooping, and often in an atmosphere which is not favourable to the vital resisting power of a fibrous structure like the sclera.

Cohn has shown that short sight is rarer in the country than in towns, in elementary schools than in advanced schools, in both than in the universities, in the lower forms of a school than in the higher, and in the lower classes of society than in the higher.

The indications are obvious:—

(1) To correct the refractive error, in order to prevent stooping and to lessen the convergence.

(2) To see that school-rooms are well lighted and ventilated.

(3) To have desks and seats adjustable to the height of each several scholar, according to well-defined rules.

(4) To use books well printed on unglazed paper, and to teach bold, upright writing.

(5) To discourage long evening work, and bookworm habits out of school hours, and to forbid impositions.

(6) To start, if possible, special schools, or separate departments in

schools, for short-sighted children, with modes of teaching adapted to give a useful education with the minimum strain on the eyes. It is hardly fair to expect the methods of an ordinary school to be altered for the benefit of a small minority, or to allow unsound eyes to compete with sound ones.[1]

(7) To exchange sedentary habits for fresh air and exercise, and to guard against inactivity of the liver and primæ viæ, which have a deleterious effect on short sight.

(8) During the attacks of choroidal congestion, to give up near work, and advise suitable medical treatment.

(9) To avoid working the eyes under conditions of bodily fatigue, or with insufficient food.

Returning to the first of these indications, there is no doubt that, except in higher pathological cases (of which more anon), the full optical correction constantly worn is the best treatment in the case of young myopes, and affords the greatest security against much progress of the affection.

An exception to this has to be made in the case of children whose calling in life would be seriously compromised by the wearing of glasses; army candidates, for instance, may be advised to abjure glasses altogether until medical examination is over, since their use undoubtedly leads to forgetfulness of that ingenious dexterity of unravelling the details of hazy objects acquired by nearly all uncorrected myopes.

Donders was the first to point out that though glasses for distant vision are a luxury, it is for near vision they should be considered a necessity, however much the child may prefer to be without them. If, however, we slightly under-correct children, who love to see objects clearly, we shall, as Jackson observes, tempt them to look obliquely through their glasses in order to see better, and thus by straining their muscles and introducing the astigmatic effect of oblique lenses, derive more harm than good from their spectacles. To make sure of not exceeding the full correction in myopes who possess an active accommodation is by no means easy, and a mydriatic is more often necessary in myopia than in hypermetropia, except when we decide to under-correct, as we may do in people who will not misuse their glasses. Since by the exercise of accommodation objects can be seen with equal distinctness through lenses which over-correct the myopia, great care should be taken to select the *weakest* glass that gives full distant vision.

This rule, it will be remembered, is the opposite of that for presbyopia, where the *strongest* convex glass had to be chosen.

When glasses are taken to for the first time by adults, it is generally needful to prescribe a reading pair weaker, by 1D or more, than the distant pair. In presbyopia combined with myopia the reading-glass should be weakened by the amount of presbyopia.

There are cases of congested choroid and irritable retina in which, during the greater part of the day, it is inadvisable to wear glasses at all, since myopic haze gives the retina more rest than the continual appeal of well-seen objects. Such cases are liable to periodical attacks of congestion of the eyes, due not only to their over-use, but also to a constitutional disturbance not yet fully understood, and it is particularly at these times that the myopia increases and the greatest dangers are run of choroiditis or hæmorrhage at the macula. It is to aggravated cases of this kind that the name malignant myopia is applied. The ophthalmoscopic appearances are described in their own section of this work.

In prescribing glasses for high myopia two or three precautions are necessary. The first is to remember that the spectacle lenses will be worn nearer the eye than the lenses in the trial frame, and thus will over-correct the defect if the trial lenses exactly correct it. A glance at Fig. 6 will show that a lens exactly corrects a myopic eye when its principal focus coincides with the far point. When, however, the same lens is brought nearer the eye, its principal focus lies within the far point, so that the light enters the eye with a greater divergency than is required to correct the myopia.

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[1] An attempt in this direction has been made near Oxford by Mr. Doyne, and is being made in Bournemouth by the writer.

This excess of divergency, though overcome by the patient's accommodation, induces eye-strain all the more for that very reason. A slight deduction, therefore, must be made from the trial lens in proportion to its distance from the eye and also in proportion to its strength. Thus a subtraction of 0·5D may be necessary from a 5D trial lens, of 1D from a lens of 10D, and of 2D from a lens of 20D, or possibly even more. Another precaution is to adjust the centres of strong lenses so as to give the most easy inclination of the visual lines to each other. The stronger a lens the greater is its prismatic effect on the visual line, when this line does not pass through the optical centre. A simple way of solving this problem, in the case of glasses prescribed for distance only, is to place the disc of glass rods in the trial frame, already filled with its lenses, and adjust the breadth of the frame till a distant flame appears to coincide with the streak. The recorded distance between the lens centres may then be prescribed unless it should be at all extraordinary.

Since the range of accommodation is shifted in myopia, by the patient's far point being nearer than infinity as in emmetropia, the near point lies nearer the eye, and its recession does not embarrass the patient till later in life, and in the case of high myopia, never.

Presbyopia.—Presbyopia is the physiological age-element that creeps in with every variety of refraction, and depends on gradual lessening of the range of accommodation from recession of the near point. It is due to decreasing elasticity of the lens, supplemented in later life by atrophy of the ciliary muscle. The condition does not receive the name of presbyopia until the nearest point for comfortable reading begins to recede beyond the distance at which books and papers are generally held. In healthy emmetropia this begins about the age of forty-five, and is evidenced by the necessity of removing near work to a rather greater distance from the eyes than formerly, and later still by the expedient, which the patient discovers for himself, of allowing a quantity of light to enter the eyes while reading in order to contract the pupil and thus increase the definition of the retinal pictures in the same way that a small stop sharpens the definition of an imperfectly focussed camera. The healthy emmetrope would generally require about a + 0·5D lens to correct his presbyopia at forty-five years of age, + 0·75D at forty-seven, + 1D at fifty, + 1·5D at fifty-five, 2·25D at sixty, 3D at sixty-five, 3·5D at seventy, and after seventy-five, from 4 to 6D, according to the generally more or less diminished acuity of vision from senile changes.

But it is always better to test the patient's near point both binocularly and monocularly, as already described, to make sure that the glasses prescribed make it lie well within the distance at which his calling in life requires his work to be, and which of course differs in different occupations. If the distance of the near point be measured with a dioptric tape, the range of accommodation can be read off in dioptres, and Landolt's plan for correcting presbyopia is to reckon two-thirds of this range available for continuous work, and add thereto the refractive aid necessary to bring this two-thirds up to the patient's work. For example, if a patient's near point lie $\frac{1}{3}$ metre away, his range of accommodation consists of three dioptres, of which two are available for constant work. Were his work, therefore, to lie at $\frac{1}{2}$ metre habitually, he would not need glasses, but were it to lie at $\frac{1}{3}$ metre, he would need lenses of 1D. Mistakes are more often made by prescribing glasses too strong than too weak, since Donders rather overestimated the requirements of the different periods of life.

In hypermetropic subjects presbyopia becomes manifested earlier in life, since part of the range of accommodation at its far end is absorbed in neutralising the refractive error, leaving only the remainder available for near work. The corrections specified above for each age in emmetropia should therefore theoretically be added to the lens which corrects the hypermetropia, but actual measurement of the near point to confirm this should not be omitted.

In myopia, presbyopia appears later in life unless glasses are worn constantly, in which case the reading pair should have an abatement of strength from the distant pair equal to the lens that would be required at the same period of life in an emmetrope. It will be seen, therefore, that while a hypermetrope of 1D will require a lens of about 2·25D at fifty years of age, a myope of 1D will scarcely need a glass at all at that age, though at sixty years he will need about + 1·5D.

Astigmatism.—Two kinds are recognised clinically—irregular and regular. The former is caused by such defects as corneal nebulæ, corneal facets, unequal refractive indices of the sectors of the lens, and in short irregularities of any unsystematic kind in cornea or lens. It is incapable of correction, except partially by the employment of a stenopæic slit or aperture.

Regular astigmatism is of two kinds, corneal and lenticular, of which the former is by far the most important. The latter is apt to neutralise the former in measure, and it is mostly due to tilting of the lens. Corneal astigmatism exists when the part of the cornea employed for direct vision is spheroidal instead of spherical, or when it is more strongly curved in one meridian than in any other.

The vertical meridian is generally that of maximum, and the horizontal that of minimum, curvature. This astigmatism, therefore, is called "according to the rule." When the reverse is the case the most strongly curved meridian is approximately horizontal, and this condition has received the name of "perverse astigmatism," since it is, with a measure of truth, supposed to give rise to asthenopia more frequently than the other kind, and to require correction more fully. The fact that a low degree of ordinary astigmatism exists physiologically in almost every eye helps to confirm this belief.

Estimation of Astigmatism.—Retinoscopy (*q.v.*) is more serviceable for the detection of astigmatism than for any other error of refraction.

Another valuable objective method is furnished by the ophthalmometer. As arranged by Helmholtz, it was suitable for physiological investigations only, but the later instrument of Javal and Schiotz is more suited for taking clinical observations. It consists essentially of a telescope (Fig. 12), directed towards the patient's eye, and provided internally with a doubling apparatus which produces two images of the cornea looked at. The telescope bears two arms which support white figures on a black ground, one of which is cut out in little steps (Fig. 13). To use the instrument these figures are placed in a strong light, that the reflections from the cornea may be studied, the arms, to begin with, being horizontal. Since each figure (or mire as it is called) appears doubled on the patient's cornea, four reflections are seen, of which two lie close together. One mire is then moved until its margin appears to touch that of the other. The curvature of the meridian may now be read off from the instrument, and if after rotating the arms through a quarter of a circle the mires still touch, there is no astigmatism. Should they overlap (Fig. 14), it shows the second meridian to be more strongly curved than the first, and to possess as many additional dioptres of refractive power as there are steps in the overlapping. Should, however, the mires, instead of overlapping, have moved farther apart, the second meridian is the less curved of the two, and after bringing the mires together again, the arms should be swung round once more to the first meridian to count the overlapping there. Should one mire appear displaced tangentially with reference to the other, it shows that the meridians of maximum and minimum curvature are oblique, and the

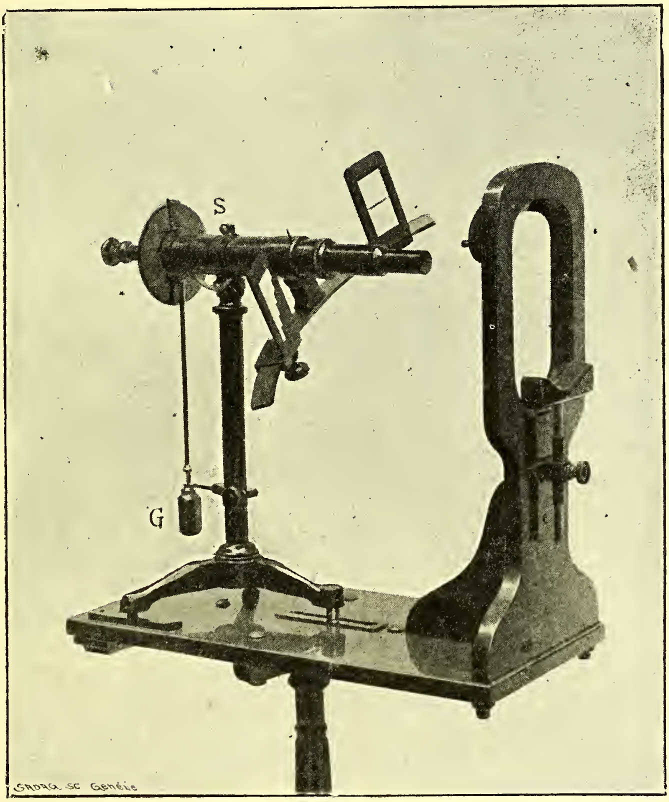

Fig. 12.—Ophthalmometer (as made by Pfister and Streit).

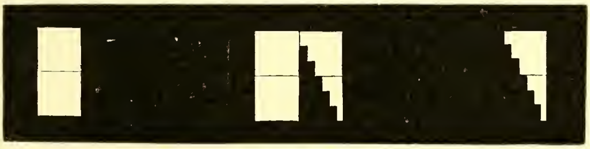

Fig. 13.

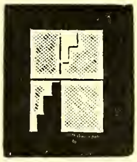

Fig. 14.

arms should be swung round till the tangential displacement is corrected. One of the two required meridians is now found, and the other is at right angles to it.

But after all has been said, the most serviceable tests for intelligent patients are the subjective ones, and all others should be supplemented by it. We may divide subjective tests into type-tests and line-tests. For the former, Snellen's test-types are used, at a distance of 6 metres, while lenses are manipulated before the eye. The best lens to begin with in an eye approximately emmetropic, or after correcting H or M as nearly as may be, is a – 0·5D Cyl., after placing a trial frame on the face with an obturator (*i.e.* an opaque disc) before the other eye. If this lens affects vision equally, with axis placed first horizontal and then vertical, there is no astigmatism, unless of the oblique kind. The next step, therefore, is to place the same lens with axis at 45° on one side of the vertical, and then axis at 135° on the other side. Whenever better vision is obtained with the axis in any one position than in a position perpendicular to it, astigmatism is detected. The lens is now to be rotated till the best position of the axis is obtained, and then left in position while other minus cylindrical lenses of increasing strength are tried in succession before it, with their axes in line with its axis, till the maximum acuity of vision is reached. But during this process care should be taken to try the effect, at intervals, of weak convex sphericals, and if vision is improved, or even made no worse by them, they should be adopted, and be associated with the cylinder in the trial frame. Moreover, the exact inclination of the axis should be confirmed as the examination proceeds, since with increasing strength of cylindrical correction the exact placing of the axis becomes more delicate and easy. Finally, a weak Cyl. of – 0·25D (or a Jackson's lens, which consists of a weak + Cyl., combined with a weak – Cyl., at right angles to each other) should be placed alternately "axis with" and "axis against" the previously found correction. If these two positions affect vision equally the astigmatism is properly corrected, and the other eye can be proceeded with in like manner.

Under-Correction of Astigmatism.—It is my impression that astigmatism, whether myopic, mixed, or hypermetropic, should be slightly[1] under-corrected, to allow play for the variable element, for though the mass of the astigmatism remains unchanged, there is a kind of fluctuating margin, like the ebb and flow of the tide, dependent on varying tone and contraction of the eyelids. This interesting subject, which has been specially studied by George Bull and George Berry, deserves a longer account than the scope of this article allows.

Line-tests.—Only the best of these need be mentioned, namely, first, those which consist of a group of radiating lines, as exemplified in Snellen's "Sunrise," or the well-known "clock"; and, second, those consisting of one or more groups of parallel lines. A single group can be rotated on the wall, or several groups of lines running in different directions may be placed near each other on a stationary card. A very good example of the last to which my attention was called by Mr. Lionel Laurence, is made by the "Montreal Optical Company." We may, however, select the "clock" to illustrate the principle of all other line-tests. In this, twelve narrow bands, each consisting of three parallel lines, radiate from a centre. After excluding one eye of the patient, and placing the clock 6 metres off, the weakest minus, or strongest plus, spherical lens should be selected which only just allows one diameter to be distinct. One meridian of the eye has now been made emmetropic, namely, that which is at right angles to the brightest ray. All that remains is to appose minus cylinders, with their axes at right angles to the brightest ray, till we find the one which makes rays at right angles to the originally brightest one equally bright also.

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[1] The advice, which the reader may have met with, to choose the weakest minus cylinder, or the strongest plus cylinder, which gives best visual acuity is based on an obvious fallacy. The weakest of either should be chosen.

It is prudent not to be content with this, but to make a final appeal to the distant test-types, for which it will often be found that a slightly weaker cylinder is best, and I have even met with a case now and then in which a slight difference of axis is preferred. When such discrepancies occur, it appears probable that the line-test is more strictly true, but that the type-tests indicate the lens which it is expedient to prescribe, at least for a time. In testing the second eye it saves time, in view of the predilection which As. displays for bilateral symmetry, to commence with lenses similar to those already found for the first eye.

ESTIMATION OF REFRACTION.—Though this has been dealt with under each heading the following general order of procedure may be described:—

Having glanced at the patient's eyes to see whether they are deep set and with contracted pupils, as in emmetropia; or whether they are prominent and with large pupils, as in myopia; and whether the eyelids look tired or drawn, and the forehead frowning, as in refractive asthenopia;—the outer canthus of each eye may be drawn back, while the eye is made to look strongly in the opposite direction to observe whether the side of the globe is short and strongly curved as in hypermetropia, or with a long gradual curve as in myopia. The tension of the eye should be tested as a matter of habit to observe the normal variations. The visual acuity both in distant and near vision (*see* art. on VISUAL A.) should next be recorded, and the near point measured. Next, one of the two chief objective tests should be applied, retinoscopy (*q.v.*), or ophthalmometry. The latter is described a little farther on. The patient should now be seated at a measured distance of 5 to 6 metres from the distant test-types, with a trial frame on his face bearing the correction already found, and with a circular vulcanite disc, called an obturator, in front of one eye. The best trial frames have obturators hinged on to them so that they cannot be lost. The defect of all trial frames which the writer is acquainted with is that they admit distracting side-lights to the patient's eyes. It would be better were they provided with side screens. The objective finding for each eye should be confirmed by the apposition of weak + and − spherical and cylindrical lenses, and the axis of a cylinder be carefully adjusted, since its position sometimes differs during attention of the eye from that which it occupies when the eye is disengaged as during retinoscopy. The visual acuity then obtained should be made a note of.

Should no objective test have been made first, the procedure may be as follows:—

A. Covering one eye with the obturator, test the vision of the naked eye by the distant test-types. Should the visual acuity be practically perfect myopia cannot be present, nor high astigmatism. It remains, therefore, to test for H or low As. To do the first, a very weak and then a stronger convex lens may be put up before the eye. If the legibility of the lower distant types is impaired by a + 0·25D, and almost abolished by a + 0·75D lens, there is no manifest H. Should the legibility be unaffected by either of these lenses, put up stronger ones till the *highest* power is reached that does not distinctly impair legibility. This lens measures the manifest H (H_m).

B. Should, however, the visual acuity of the naked eye have been poor at first, the case may be one of myopia. Try, therefore, a rising series of concave lenses till the *weakest* is found that affords the best obtainable vision.

C. Next, test for astigmatism, by directing attention to a line-chart with any previously found myopia slightly under-corrected, or hypermetropia over-corrected. If lines in some certain direction stand out more boldly than others, proceed, as already described under "Astigmatism," by putting up concave lenses, with axes perpendicular to these bold lines, till the lines are made equally bright in all directions, and then confirm the result by the test-types. If two consecutive *cylinders* appear to have the same effect, retain the *weakest*, whether + or –. From this remark it will be seen that the rule for the strongest convex and weakest concave does not apply to cylinders, but only to spherical lenses.

To summarise, if the naked eye has

A. Full visual acuity. There is either
  (*a*) Emmetropia, or
  (*b*) Hypermetropia (facultative) or
  (*c*) Low astigmatism.
B. Poor visual acuity. There is either
  (*a*) Myopia, or
  (*b*) High hypermetropia (not fully neutralised by accommodation), or
  (*c*) Astigmatism.

PRISMS AND THE DECENTERING OF LENSES.—It is sometimes desirable to combine a prism with a lens, especially in hyperphoria (*q.v.*) or for diplopia. The simple rule may be made that a prism appears to drive the image seen through it in the direction of its "edge" or "apex." If a simple mnemonic metaphor may be permitted, the image flies before the edge of the sword. If strong, the prism should be divided between the two eyes. The prismatic result can be obtained by decentering a lens, the rule being that for each degree of prismatic effect desired, the lens should be decentered by a distance equal to $1\frac{3}{4}$ cm., divided by the numbers of dioptres in the lens. As regards the direction of decentering, since the thinnest part of a concave lens is at its centre, this centre should be displaced in the direction of the thinnest part or apex of the required prism, the reverse being the case with a convex lens, for since its centre is its thickest part it should be displaced in the direction of the base of the required prism. A scale constructed by the writer for the measurement of hyperphoria is obtainable, with directions thereon as to the amount of decentering that is necessary to correct any defect.

It is evidently important in all cases of decentering to know what point to decenter from; in other words, to know the exact distance between the eyes, and whether one eye is higher than the other. Numerous pupillometers exist for this purpose. The most accurate are those that require the patient to look at a distant object through two pin holes, but this requires too much intelligence for most patients. The pupillometers in ordinary use, which allow the prescriber to take the measurement, are subject to errors from parallax, since they secure no fixed point of view for the examiner's eye. The "localiser" is free from this defect, and also has the advantages that it can measure the inter-pupillary distance in squinters just as easily as in ordinary cases, and can measure the distance of each eye from the middle of the nose, and the elevation of one pupil over the other. It is made in metal to fit the trial frame, and is placed just before one eye and then another, enabling the observer to "sight" the patient's pupil as along a gun, while his own pupil is looked at by the patient. A slight modification of this instrument is now made, since it has occurred to the writer to utilise an ophthalmoscopic reflection from the cornea for measuring the distance between the visual lines, this reflection appearing to him to afford by far the most rational landmark for the purpose, since it marks out more closely than any other the very spot of the cornea traversed by the visual axis. All errors from high angle gamma, too, are thus avoided.[1] All that is necessary is to adjust the trial frame with the localiser in it, till the reflection, the notch, and the point are all in a line. It is only for strong lenses and special cases that such accuracy is required, and for ordinary work the usual pupillometers suffice.

REFRACTIVE HEADACHES.—The effort of accommodation in H, or its embarrassment in As, is very apt to give rise to a species of "referred pain" of a dull and continuous character, which may vary from a slight heaviness over the eyebrows to a more distressing widespread headache. In either case an area of tenderness may be found, sometimes, if sought for, after reading, just over the root of the nose. Sometimes the headache itself is confined to the same spot, but more often it is over each eyebrow. Occipital headache is by no means a rare accompaniment, but more generally implies either fatigue of the cerebral visual centres or defects of the extra-ocular muscles. Headache in one or both temples, or at the vertex, is more rarely of ophthalmic origin.

Refractive headaches are at first only disposed to occur towards the end of long spells of reading or fine work, but when more pronounced the subject wakes with them in the early morning. Gradual relief sets in during the morning hours, but evening work again aggravates the discomfort. In contrast to this daily headache we often meet with cases in which migrainous headaches, more or less periodical, are set up by refractive errors, with freedom from any pronounced headache in the intervals. Headaches sometimes cease entirely from the first day the correcting glasses are adopted, but more frequently it takes a few weeks to get sufficiently accustomed to their novelty to obtain their full benefit.

Simple myopia never causes headaches, though a myopic eye is sometimes the seat of congestive neuralgia. A curious feature about astigmatism is that low degrees are just as liable to cause headaches as the higher degrees, and especially if the principal meridians are oblique, or if the horizontal meridian of the cornea is more strongly curved than the vertical. It often only begins to give trouble about the age of thirty, and refractive headaches nearly always begin to die away after the age of fifty. "Headache spectacles" should be worn continuously to get the best effect.

Relapsing Fever.

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SYNONYMS.—*Typhus recurrens, Famine fever, Spirillum fever;* French, *Fièvre à réchute;* German, *Armen-typhus.*

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[1] The angle gamma is the angle between the fixation line and the geometrical axis of the eyeball. It is greatest in hypermetropia, and least in myopia.

Definition.—An acute infectious fever, characterised by the presence of a spiral micro-organism in the blood, by a rapid onset and defervescence, and by a repetition of the fever after a week's apyrexia.

History.—There seems to be no doubt that this fever is one of the diseases described by Hippocrates, although his description would appear to include cases which may, with more probability, be referred to other conditions. Singularly enough, however, it is not till 1739 that we find an account of an epidemic of relapsing fever, Rutty at that date giving an accurate description of it, though he did not distinguish it definitely from other fevers prevalent in Dublin at that time. The disease seems to have been frequently prevalent in Ireland, and particularly so in the first sixteen years of the nineteenth century. In most cases its epidemic prevalence coincided with that of typhus, a fact which prevented a definite distinction between the two fevers being made till Henderson of Edinburgh finally separated them in 1843, after both diseases had been epidemic for over two years. Since that time, as far as this country is concerned, relapsing fever has been of rare occurrence, the last cases in Great Britain occurring in 1869-70, although cases are reported as having occurred in Ireland since that date.

As regards *geographical range*, the fever may apparently exist in any climate. It has been during the nineteenth century fairly common in Northern Europe, very prevalent in Silesia, and is still to be found in Russia. It has also been of frequent occurrence in the famine districts of India. On various occasions it has appeared in North America, and its presence has also been noted in Algeria.

Etiology.—Relapsing fever has a particular interest in that it is caused by a micro-organism belonging to the group of protozoa. This organism is a spirillum, long and slender, and of varying length (16 to 40 μ), pointed at the ends, and, as Koch has succeeded in demonstrating, provided with true flagella. In fresh blood it is actively motile, and attention may be drawn to it, on microscopical examination, by the manner in which the blood corpuscles are moved violently aside by its rapid movements. It stains readily with the ordinary basic aniline dyes, and may be searched for either in fresh blood, or by fixing blood on a cover-glass in the ordinary manner, washing in 1 per cent acetic acid, and afterwards in water, and then staining with gentian violet.

The spirillum is present in the blood during the whole of the primary attack, and also during the relapses. In the apyrexial intervals, however, it is not to be found, but the experiments of Metschnikoff have proved that they may, during this period, be present in masses in the spleen.

The vitality of the spirilla may be preserved for a considerable period, provided they are not exposed to heat, as a comparatively low temperature is sufficient to destroy them. All attempts to cultivate them on artificial media have failed, and the inoculation experiments performed on monkeys have been done with the blood of a patient suffering from the disease. Monkeys so inoculated develop large numbers of spirilla in the blood, and have a fever of short duration, terminating by crisis, but not followed by a relapse. The evidence at present is distinctly in favour of the spirillum which is known as the *Spirochœte Obermeieri* (its discoverer in 1873) being the real cause of the disease.

The more *remote causes* which favour the occurrence of an outbreak of relapsing fever, and increase the chances of its spread, are said to be destitution and famine. Indeed the latter condition has given the fever one of its most frequently used names. Overcrowding naturally favours the spread of any infective disease, and as this fever has been most frequently observed among the poorer classes, it is only natural to find conditions of overcrowding almost always associated with epidemics. Insufficiency of food may only be a cause in that it naturally weakens the resistance of the exposed person. In the outbreak in 1869 both Rabagliati in Bradford and Muirhead in Edinburgh noted that their patients were all sufficiently well nourished. All agree that, for some reason or other, males are more frequently affected than females. As regards age the fever is a disease of early life.

Mode of Infection.—The most common method by which infection occurs is direct contact with a person suffering from the disease. Entering a badly ventilated room in which a patient is lying, is sufficient to cause infection. As in typhus, therefore, infection would appear to be, to some extent, conveyed by the air, and to be contained in the exhalations of the patient. Murchison has noted that women working in hospital laundries frequently contract the disease, and we may therefore assume that the poison may be carried by fomites.

MORBID ANATOMY.—Except for the usual microscopic conditions resulting from pyrexia, there is nothing to be found on post-mortem examination. Nothing characteristic or pathognomonic has been observed in fatal cases. The spleen is always much enlarged.

SYMPTOMS AND COURSE.—*The period of incubation* appears to be very variable. In certain cases the disease seems to develop within a few hours of exposure. On an average five to ten days may be taken as the most probable time, though occasionally the period is prolonged to a fortnight.

The first paroxysm commences abruptly, the patient being suddenly seized with rigors, often severe, pains in the back and limbs, headache most marked in the vertex and occiput, and by a marked sensation of giddiness. This last symptom usually compels him to take to his bed at once. The temperature rises rapidly, and in a few hours may rise to anything between 102 and 106 degrees, even higher figures being occasionally recorded. The skin is dry and hot, and the patient at this stage is usually flushed, though even in the first twenty-four hours the skin may present the yellow tinge which is characteristic of this fever. The pulse is rapid, and is usually raised above 110, occasionally reaching 140 beats per minute before the end of the second day. As the fever progresses the tongue becomes covered with a thick yellow fur, but in the majority of cases it remains moist. Delirium may set in early, but is as a rule delayed for two or three days.

The temperature remains high during the paroxysm, morning remissions being only slight. A level of about 104° seems a fair average. The respiration becomes hurried, and frequently exceeds thirty. Cough is a common symptom, and auscultation reveals rhonchi and harsh breathing. The patient is tormented by excessive thirst, and frequently suffers from severe and persisting vomiting of greenish yellow matter. Jaundice is common, and nearly every case presents a distinct icteric tinge in the conjunctiva. The liver is enlarged and tender, and the spleen is also increased in size. The bowels are as a rule constipated. In bad cases the patient may be congested, or livid in the face. A certain percentage of cases, apparently, show a rose-rash on the trunk and limbs. The spots resemble small typhoid spots, though their distribution is more apt to suggest typhus. They do not disappear on pressure.

After from five to seven days of continued fever the paroxysm terminates as abruptly as it started, by a remarkably sharp *crisis*. It may be ushered in by slight diarrhœa, and is always accompanied by very profuse sweating. The fall of the temperature may be as much as 10° Fahr. in twenty-four hours, and may continue till the thermometer registers only 94 or even 92 degrees.

After the crisis the patient enters on the "*first period of apyrexia*," or the "intermission." All the symptoms of the previous week have disappeared. A man who a day or two previously has been absolutely helpless, delirious, possibly in the "typhoid state," declares himself quite well, and is with difficulty persuaded to remain in bed. But on about the fourteenth day of the disease, that is to say, roughly speaking, a week after the crisis, the relapse starts as suddenly as did the original fever.

The *relapse*, or second paroxysm, except that it is usually a day or two shorter in duration, is simply a repetition of the first paroxysm. Once again the fever commences with rigors, headache, and giddiness, and the temperature rapidly rises. The pulse is often, if anything, more rapid than in the first attack, but this appears to have little significance, Rabagliati having noted pulses of even 160 in favourable cases. The thirst, jaundice, and vomiting may be as bad as ever, but, broadly speaking, the relapse is, as a rule, slightly less severe than the first paroxysm. The patient usually voids a greater quantity of urine than in his first attack, and this increase is most frequently noticed just before the crisis, one of Muirhead's patients having passed 84 oz. in the twenty-four hours.

The second crisis is in every way comparable to the first. The temperature falls with equal rapidity, and the sweating may be even more severe, sudaminal rashes being of common occurrence. Subnormal temperature for some days after is the rule, and there may be a considerable amount of prostration.

The *second period of apyrexia*, which usually coincides with the *period of convalescence*, is now reached. Occasionally there may be, however, a second or even a third relapse. If such is the case, the symptoms are, as a rule, milder. The convalescence is at times protracted and interrupted by complications.

COMPLICATIONS AND SEQUELÆ.—Pharyngitis is a common complication. Vomiting and diarrhœa may be so severe as to assume the importance of complications. Bronchitis is not uncommon, and occasionally pneumonia has been noticed. Œdema glottidis and laryngitis are also met with. Epistaxis is frequently observed. Delirium is most frequently seen just before the crisis, but occasionally persists through the whole fever. Insomnia is of common occurrence. The most important sequela is ophthalmia, which seems very liable to occur in convalescence. Glandular enlargements in the neck, groin, and parotid are not unusual.

DIAGNOSIS.—The most certain method is microscopic, the detection of the spirillum settling the question finally. Apart from this, diagnosis depends on the presence of an epidemic, on a sudden onset of high fever, with giddiness, slight jaundice, and vomiting, and on the marked crisis. The fever is most likely to be confused with influenza, typhus, and malaria. The occurrence of the relapse removes any difficulty.

PROGNOSIS.—This may be said to be uniformly favourable except in old persons and complicated cases. The death-rate seldom exceeds six per cent. Severe diarrhœa, marked jaundice, and excessive prostration are the worst symptoms.

TREATMENT.—It seems to be generally agreed that there is nothing which influences the course of relapsing fever. All that can be done is to treat symptoms and complications as they arise. A tonic treatment with strychnine or nux vomica has been recommended. Insomnia should be appropriately combated. Quinine and other drugs have been tried without success with a view of preventing the relapse.

Renal Colic. *See* Colic; Kidney; Nephritis.

Respiration.

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Absorption of oxygen and elimination of carbon dioxide, two conditions essential for the maintenance of the vitality of every animal organism, together constitute the process of respiration. In all the higher animals there is (*a*) external respiration, the interchange between the gases of the blood and those of the water or air, whereby O is absorbed and CO_2 eliminated, and (*b*) internal respiration, the interchange between the gases of the blood and lymph on the one hand and those of the tissues on the other, the blood thereby gaining CO_2 and parting with O. In man the lungs are the chief seat at which O is taken into the organism and at which CO_2 is eliminated.

The visceral layer of the pleura, covering the outer surface of the lung, is in intimate contact with the parietal pleura forming the innermost layer of the thoracic wall. The lungs themselves are highly elastic, and from the time of birth onwards are distended with air. But if air enter the pleural cavity—in which there is normally a state of negative pressure—the lung collapses or recoils in consequence of its elasticity, and part of the thorax, formerly filled by distended lung, is then filled with air.

In respiration there is an alternating indrawing of air into and expulsion of air from the lungs, these processes being termed respectively inspiration and expiration.

Inspiration.—As the intrapulmonary pressure is reduced by any enlargement of the thoracic capacity, each thoracic expansion will be followed by the drawing of air through the trachea and bronchi into the lungs. Inspiration is the result of muscular action; contraction and consequent descent of the diaphragm increases the vertical diameter of the thorax, the transverse diameter of which is enlarged by the elevation and rotation outwards of the ribs, whilst an increase of the antero-posterior diameter is due to a movement upwards and outwards of the ribs, costal cartilages, and, it may be, of the sternum also. The chief muscles of ordinary inspiration are, apart from the diaphragm, the external intercostals, which, on contraction, elevate all the ribs except the first. Less important inspiratory muscles are the intercartilaginous portions of the internal intercostals, the scalenus anticus, serratus posticus superior, and the levatores costarum. Many other muscles may act as muscles of forced inspiration, but of these the most important are the sterno-mastoids, scaleni, trapezei, and pectoral muscles. Thoracic expansion during inspiration is not of uniform character in all persons. In young children inspiration is mainly caused by the diaphragm, the type of respiration being termed abdominal; in men respiration is mainly of the diaphragmatic or abdominal type, whereas in women the inspiratory expansion is most marked in the upper part of the thorax, this being known as the thoracic type of respiration.

Expiration under ordinary circumstances is a purely passive movement. The action of the inspiratory muscles having ceased, the distended lung partially collapses, and in doing so draws inwards the thoracic wall, which moreover tends to return to the state prior to the inspiratory movement owing to the elastic recoil of the costal cartilages, to the action of gravity acting on the chest wall, and also to retraction of the abdominal muscles. In emphysema, deficiency or loss of the pulmonary elastic tissue is one of the main causes of the difficulty in expiration, and of the consequent permanent over-distension of the lungs. Forced expiration is effected by various muscles, of which the most important are the muscles of the abdominal wall; yet all muscles which depress the ribs or compress the abdominal viscera, the serratus posticus inferior, the interosseous portions of the internal intercostals and the sacro-lumbalis, for example, are accessory muscles of expiration.

Respiratory Rhythm and Rate.—In normal respiration inspiration and expiration succeed each other rhythmically, and the length of time occupied by inspiration in relation to that of expiration is on an average represented by the ratio 5 : 6; whilst after the completion of expiration there is a short pause. The most marked deviation from the normal respiratory rhythm is seen in Cheyne-Stokes respiration (see p. 346). In man the number of respiratory movements per minute is about 14-20; but even within physiological limits the frequency of respiration varies greatly in accordance with such factors as age, posture, exercise, and so forth, the frequency being, for example, greater in infancy and childhood than during adult life, and being decreased in any individual when he assumes the recumbent posture.

The volume of air inspired during each ordinary inspiration, *tidal* air as it is termed, amounts to about 500 ccm., or 30 cubic inches. *Complemental* air is the further volume which by the deepest inspiration can be indrawn after an ordinary inspiration; *supplemental* or *reserve* air is the volume which can be forcibly expelled after ordinary expiration is completed; *residual* air is that remaining within the lungs after expulsion of the reserve air. The *vital* or *respiratory capacity* of an individual is the volume of air which he can expel after as forcible an inspiration as possible. The vital capacity varies with the sex, age, height, and weight of the individual, but averages about 3500 ccm. to 4000 ccm.

Changes in Respired Air.—The atmosphere consists of 20·96 volumes per cent of oxygen, about 79·0 volumes per cent of nitrogen, and 0·03 volumes per cent of carbon dioxide; further, the inspired air contains a variable quantity of watery vapour, usually contains dust particles, and always contains micro-organisms in greater or lesser numbers (see p. 348). The air, on passing through the nose, trachea, and bronchi, gains moisture, and its temperature is raised, and by diffusion its gases then mix with those of the air persisting in the pulmonary alveoli. The expired air, as compared with that inspired, is warmer, poorer in oxygen of about 4 per cent, but richer by about 4 per cent in carbon dioxide, and richer in aqueous vapour. The chief of these alterations are consequent on an interchange between the gases of the alveolar air and those of the blood in the pulmonary capillaries. The arterial blood of man contains about 21 volumes per cent of oxygen, and 40 volumes per cent of carbon dioxide, whilst venous blood coming to the lungs contains about 7-12 volumes per cent less O, and about 8 volumes per cent more CO_2. It is, therefore, evident that the blood in passing through the lungs gains oxygen and parts with CO_2, and this interchange of gases is probably largely due to gaseous diffusion. For the tension of oxygen in alveolar air is greater than that of the oxygen in venous blood, whereas the tension of carbon dioxide in venous blood is greater than that of the carbon dioxide in alveolar air. The oxygen is, however, not merely dissolved in the blood, but is in chemical combination with hæmoglobin, and, moreover, there are probably other factors besides diffusion concerned in the gaseous interchange.

The Nervous Mechanism of Respiration.—The special respiratory muscles are innervated from different parts of the central nervous system. The diaphragm is innervated through the phrenic nerves, the intercostal muscles through the intercostal nerves, the muscles which open the glottis through the inferior laryngeal branches of the vagus, and the muscles of the alæ nasi through the facial nerves. The impulses transmitted through these nerves are dependent upon and co-ordinated by the respiratory centre which is situated in the medulla oblongata. The precise situation in the medulla of the cells constituting this centre is a matter of some dubiety; Flourens in 1824 regarded the centre as being located just below the apex of the calamus scriptorius, but the observations of later investigators indicate that the cells forming the centre lie in the formatio reticularis on both sides of the median line.

The activity of the centre is automatic; it can act independently of any afferent impulses. It is generally supposed that the automatic activity of the centre is dependent on stimuli derived from the blood, in that the cells are stimulated to activity by a venous condition of the blood, but whether excess of carbon dioxide or deficiency of oxygen be the determining factor is as yet undecided. The centre may, however, be stimulated reflexly by afferent impulses, and that the centre is constantly being influenced by such stimuli is shown by the fact that although, when the centre is cut off from all afferent impulses, respiration continues, it consists in rhythmic spasmodic movements the frequency of which gradually diminishes till the movements finally cease entirely. Of all afferent impulses acting on the respiratory centre the most important are those transmitted by the vagi, these nerves being essential for the normal respiratory rhythm, and being the sole nerves whereby afferent stimuli are constantly reaching the respiratory centre. After division of both vagi, the respiratory movements become markedly slow and deep, and it has been determined that the nature of the vagus influence is that of accelerating and shortening the amplitude of the respiratory movements, this being effected by the inhibitory impulses produced by distension and collapse of the lung.

When the *superior laryngeal nerve* is stimulated there is inhibition of the inspiratory movement, and with a stronger stimulus forced expiratory movements are induced.

Stimulation of the *glosso-pharyngeal nerve* results in transient cessation of respiration. This is a constant phenomenon during the act of deglutition.

Stimulation of any ordinary sensory nerve is usually followed by acceleration and lengthening of inspiration, a well-known fact of considerable clinical importance.

The influence exerted on the respiratory centre by the higher parts of the brain is as yet imperfectly determined. Still it is improbable that in a normal state such impulses are constantly in action, for if, the vagi being intact, a section be made through the upper level of the medulla, respiration continues in a normal manner. If, however, the vagi also be divided, the normal respiratory rhythm is markedly affected, long inspiratory movements alternating with prolonged pauses, and the animal finally dies of asphyxia.

If from any cause there be interference with the respiratory movements, or if there be obstruction to the pulmonary circulation, or should there be any other cause, such as anæmia, for example, interfering with the interchange between the gases of the alveolar air and those of the blood, the resulting venous state of the blood increases the activity of the respiratory centre. The rate and depth of the respiratory movements are then increased, and the condition is known as that of *hyperpnœa*. Should the venous state of the blood increase in intensity, the respiration becomes more markedly difficult, and there is a condition of *dyspnœa* (*q.v.*), which, should the cause be sufficiently great and its period of duration sufficiently prolonged, passes into the state of *asphyxia* (*vide* vol. i. and vol. vii. p. 427), and this in turn may cause death.

In contrast to dyspnœa there is the condition termed *apnœa*, in which the respiratory movements are rendered shallower than normal, or brought to an entire standstill as the result of repeated forcible inspirations. Unless the vagi be divided, apnœa is not due to excessive oxygenation of the blood; when these nerves are intact the apnœa is caused by the repeated inspirations stimulating the inhibitory fibres of the vagi.

The *muscle fibres of the bronchi* are innervated by motor fibres of the vagus. Stimulation of the peripheral end of either vagus nerve results in constriction of the bronchioles of both lungs, whilst if the vagi be intact, stimulation of sensory nerves also causes reflex contraction of the bronchial muscles. Spasm of the bronchial muscles probably causes less difficulty in the entrance of air through the bronchioles than in exit of air through them, and such spasm is the most uniformly accepted explanation regarding the nature of asthma (*q.v.*).

CHEYNE-STOKES RESPIRATION.—In disease considerable variations from the normal respiratory rhythm are not uncommon. Firstly, there may be undue prolongation of inspiration or of expiration, and a condition of inspiratory or of expiratory dyspnœa (*q.v.*). Again, the respirations may be irregular, and the irregularity may be rhythmical or arhythmical in character. Respiration of the latter type is common in association with cerebral affections. In cases of cerebral hæmorrhage or tumour, for instance, the character of the respiration may be irregular, as well as slow and sighing or stertorous; whilst in the later stages of meningitis there is often an arhythmical irregularity, combined with rapidity and shallowness of the breathing.

Of rhythmical irregularity there are various varieties. Thus the respiration may be intermittent, the natural rhythm being at regular intervals suddenly interrupted by a complete pause. But the most striking variety of rhythmical irregularity is that termed *Cheyne-Stokes respiration*. In this type there are two alternating phases, the first one being that of apnœa, and there being a complete cessation of respiratory movements, and the second being a period of gradually increasing and then gradually decreasing respiratory activity. At the commencement of this latter phase the respiratory movements are feeble, faint, and shallow, but each successive respiration becomes fuller and more rapid till a maximum of forcible inspiration and expiration is attained, whereupon the rate and force of the subsequent respiratory movements gradually decrease until the breathing becomes so feeble as to be barely appreciable, and, finally, there is complete cessation of respiration. The cessation of respiratory movement, or the period of apnœa, having lasted for a variable time, the respirations commence once more in the manner described. The duration of the respiratory pause is usually about twenty, rarely more than thirty seconds, the period of activity lasts as a rule about forty or forty-five seconds, and the whole cycle extends over a period of a minute or rather more. The number of respirations occurring during the period of activity is subject to variation, though usually about fifteen or twenty. The above description is that of typical Cheyne-Stokes breathing, but frequently rhythmical irregularities of respiration do not conform exactly to the type, and are to be regarded as varieties or modifications of Cheyne-Stokes respiration.

The onset of Cheyne-Stokes breathing may be sudden, as in cases of cerebral hæmorrhage or of head injury, but is usually gradual and insidious, being preceded by dyspnœa and a rhythmic irregularity of respiration. When once developed, however, it is most marked if the patient be kept thoroughly quiet and at rest, or if he be asleep, and still more so if he be unconscious.

In some cases the pupil is contracted during the period of apnœa, dilated during that of dyspnœa, but in other instances the pupil is uniformly small. In some cases, further, there is an increase of blood pressure with retardation of the pulse apparent at the end of the respiratory pause, becoming more marked during the period in which the respirations are increasing in force, and disappearing as the respiratory movements become feebler.

Cheyne-Stokes respiration is seen as a symptom of various diseases. It is more frequently seen in association with *uræmia* than with any other condition; it may occur in cases of acute nephritis, but is exceedingly common as one of the uræmic phenomena in the late stages of chronic Bright's disease, whether the kidneys be the seat of chronic parenchymatous nephritis, or whether there be chronic interstitial changes with arterio-sclerosis.

It is also frequently observed in cerebral affections such as tumours, hæmorrhage, meningitis, etc.

Cheyne-Stokes respiration, again, is often developed in the course of *cardiac disease,* usually in cases of chronic valvular disease with associated myocardial degeneration and arterio-sclerosis, or in cases of primary disease of the myocardium, and very rarely in cases of acute cardiac disease. In this group of cases the Cheyne-Stokes respiration is probably more directly due to the vascular disease than to any secondary implication of the kidneys.

Lastly, this form of respiration has been recorded in fatal cases of sunstroke, and in rare instances in connection with other conditions. Whatever be the morbid condition with which the Cheyne-Stokes respiration is associated, its occurrence is a matter of serious import; and though it does not invariably imply that disease is about to terminate fatally, yet the prognosis becomes more grave than it would otherwise have been.

The explanation of Cheyne-Stokes respiration has been the subject of much controversy. Traube's theory assumed that the excitability of the respiratory centre is reduced, and that CO_2 is present in excess in the blood. Filehne supposed that the CO_2 accumulating in the blood during the respiratory pause causes stimulation of the vaso-motor centre, and consequent arterial contraction. As a result the blood becomes still more venous, and the respiratory centre is then gradually awakened to activity, but oxygenation of the blood being effected the activity of the respiratory centre diminishes, and consequently the rate and force of the respiratory movements are reduced. According to Franck the irregularity of respiration is dependent on impairment or inhibition of the cerebral control exerted on the respiratory centre.

Bacteriological Aspects of Respiration.—As has been already stated, the air always contains micro-organisms. The majority of these are probably saprophytic and innocuous, and need not be considered further. Others, however, are pathogenic, and a few points regarding them are here dealt with. These bacteria exist in the air under two conditions: firstly, adherent to fine dust particles; and, secondly, within minute fluid droplets. In considering what risk an individual incurs by the respiration of air containing bacteria attached to particles of dust, it must be remembered that, although bacterial spores and tubercle bacilli withstand desiccation, most bacteria do not long maintain their vitality in the absence of moisture. The inhalation of a dust-laden atmosphere is in itself, therefore, probably capable of causing infection only when there are tubercle bacilli or spores, such as those of the *B. anthracis*, associated with the dust particles.

The minute fluid droplets which contain bacteria are probably more dangerous than solid particles. It was in 1897 that Flügge first demonstrated that phthisical individuals on coughing set free minute droplets of sputum which remain suspended in the air; and it was also proved that when any individual coughs, sneezes, or speaks, he causes the liberation from the secretions of the mouth, nose, or pharynx, of minute fluid droplets which contain bacteria. These droplets are then in suspension in the air, and a current of air with a velocity of rather less than 0·1 mm. per second suffices to convey them still farther from the individual. Again, it is now known that such minute droplets, being inhaled, whether by the nose or mouth, may be carried down even into the finest bronchi by the current of inspired air. It is therefore evident that a patient affected with respiratory disease, such as tuberculosis, coryza, bronchitis, or influenza, disseminates in his vicinity droplets containing pathogenic bacteria; and it is also evident that not only are persons in the neighbourhood of that patient almost certainly inhaling those bacteria, but that the patient himself must inhale many of the bacteria which he has previously set free. It appears doubtful whether fluid droplets can be liberated from the tenacious sputum of ordinary croupous pneumonia.

But the mere inhalation of pathogenic bacteria does not suffice to cause infection, for the organism is well provided with means of protection. Large numbers of the inhaled bacteria will impinge against the mucous membrane of the nose and naso-pharynx, the former of which, at least, is known to possess marked bactericidal power; and such bacteria as are carried to the bronchi will likewise be destroyed, owing to the bactericidal power inherent in the bronchial mucous membrane, or having impinged on the cilia, will be eliminated during subsequent expiratory acts. The lower parts of the normal respiratory tract, therefore, are not invariably sterile, and may at times contain various micro-organisms. But as bacteria entering the healthy trachea or bronchi of man are probably quickly destroyed, these portions of the respiratory tract and also the pulmonary alveoli may, as a rule, be regarded as sterile, as in point of fact they are usually found to be in the smaller animals. If, however, there be a local predisposition to disease, or if the resistant power of the organism be reduced, pathogenic bacteria on being inspired will cause infection.

Rest. *See* THERAPEUTICS.

Resuscitation. *See* ASPHYXIA.

Retention. *See* URINE.

Retina and Optic Nerve.

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AFFECTIONS OF THE OPTIC NERVE

ANATOMY.—On leaving the eyeball the optic nerve courses backwards to the apex of the orbit, and then, passing through the optic canal, enters the cranial cavity. It now very soon joins its fellow of the opposite side, their junction forming the optic commissure or chiasma, where an important redistribution of nerve-fibres takes place. The newly distributed fibres, leaving the commissure, are again collected into bundles, now called the optic tracts, which pass backwards between the temporal lobes and the crura cerebri.

In the first and greater part of its orbital course the nerve is surrounded by fat, but deeper in the orbit it comes into closer proximity to the muscles arising from the apex, and at the optic foramen the nerve is in close relation with their tendons of origin.[1] About midway in its passage through the orbit the nerve receives the central vessels, which enter it from beneath and then run forward in its axis. Until it gains the interior of the cranial cavity the optic nerve is protected by a thick, loosely fitting outer sheath.

The ophthalmic artery accompanies the optic nerve in its passage through the optic canal, which latter affords little more than bare space for these structures to pass. It is important to observe that the bony plate forming the inner wall of the canal is very thin, and that this alone separates the optic nerve sheath from the sphenoidal sinus.

The chiasma rests on the optic groove; above it the third ventricle is situated. The internal carotid arteries lie on either side, while close behind it is the pituitary body.

If we now examine the optic nerve more particularly, we find that in the optic canal and orbit it is surrounded by a tubular prolongation of the meninges, and we can recognise a dural, pial, and arachnoidal sheath. The dural sheath surrounds the nerve loosely, while the pial sheath is closely applied; the interval between these (intervaginal space) is subdivided by a fine prolongation of the arachnoid into two parts, subdural and subarachnoid, which communicate with the corresponding intracranial spaces. The highly vascular pial sheath sends processes inwards, which form a framework separating the bundles of nerve-fibres. Between each mesh of this framework and the nerve-fibres enclosed in it, there is a narrow interval occupied by lymph. By the lymphatics of the pial sheath, and by those which accompany the central vessels on their entrance into the nerve, there are communications between the lymph-spaces in the interior of the nerve and the intervaginal space. If we trace the nerve-sheaths forward to the eyeball, we find that the dural and arachnoidal sheaths here join and turn away from the nerve to be continued into the sclerotic, while the pial sheath is also united with the sclerotic and sends a few fibres into the choroid. The intervaginal space consequently ends abruptly in the sclerotic around the optic nerve entrance, and this has an important significance in pathological processes.

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[1] These tendons of the superior and internal recti are closely incorporated with the optic nerve-sheath, and owing to this relation it has been asserted that movements of these muscles are particularly liable to cause pain in cases of retro-ocular neuritis implicating the nerve-sheaths in this locality.

The intraocular end of the nerve is seen with the ophthalmoscope. It is situated to the nasal side of the centre of the fundus, and is known as the optic disc or papilla. The optic disc is nearly circular, but usually somewhat oval vertically; it is of a light orange-pink colour, with a characteristic superficial translucency. Its edge is traceable all round, but is most distinct outwards, and here the disc itself is also rather paler than elsewhere from the nerve-fibres and capillaries being fewer. About the centre of the disc we can observe a depression surrounded by the converging nerve-fibres; this is known as the physiological cup or pit, and frequently its floor presents a dappled appearance, grey spots separated by white interlacing lines. The white tissue or lamina cribrosa is the thick anterior end of the pial framework, while the grey marks are the meshes occupied by nerve-fibres. Also, near the centre of the disc the retinal blood-vessels first come into view, the arteries narrower and lighter in colour than the veins. On the disc the nerve-fibres are naked axis-cylinders, but they acquire a medullated sheath at the lamina cribrosa. In the rest of their course they are like the fibres of the white substance of brain and spinal cord; they are medullated and invested by neuroglia, but destitute of primitive sheath.

The functionally most important fibres are those coming from the ganglion cells around the fovea centralis (macular bundle). At the optic disc these fibres occupy the outer third, but after leaving the eyeball they soon gain a central position in the nerve-trunk, and continue as axial fibres of the nerve until it ends in the chiasma. Although arising from a small part of the retinal expansion, these macular fibres occupy a relatively large part of the nerve area (as seen on transverse section); this is due to the fact that each of these fibres represents the central connection of a single retinal element (cone), while each of the more peripheral optic nerve fibres is connected with several retinal elements.

The other fibres, coming from the upper, lower, outer, and inner parts of the retina, occupy a corresponding area (upper, lower, etc.) of the optic nerve trunk. The most central fibres at the disc are those which come from the most peripheral parts of the retina, while the fibres situated next the pial sheath of the nerve-trunk come from the retina immediately around the disc. It is important to recollect this, for it shows that an enlargement of the normal "blind spot" will be the first result of an inflammatory or atrophic process affecting the fibres at the periphery of the nerve trunk.

At the chiasma the optic nerve fibres undergo a rearrangement, one important bundle being continued into the optic tract of the same side, while the remainder (constituting the larger bundle) cross over into the opposite tract. The non-crossing fibres correspond to those coming from the temporal half, and the crossing fibres to those coming from the nasal half of the same retina; the line dividing the retina into these two halves passes vertically through the macula lutea. Each tract, consequently, contains fibres from its own side (right or left) of both retinæ. It follows that a loss of function in one optic nerve will mean a visual failure confined to the same eye, while lesion of one tract is followed by visual failure of both eyes, but only of those fibres coming from the homonymous side of both (right or left), and will therefore be expressed by the loss of the opposite half-field (left or right homonymous hemianopia). Lesion of the chiasma may implicate fibres from one eye only, or from both; the most usual implication of the chiasma is central, affecting the crossing fibres from both nasal retinæ, so that bi-temporal hemianopia is the result (see article on "VISUAL FIELD").

Each optic nerve fibre is the central process (axon) of a retinal ganglion cell, and is nutritionally dependent upon this cell. The conducting value of the fibre may consequently be impaired in two distinct ways—by an affection (*a*) of the ganglion retinæ, or (*b*) of the fibre itself in any part of its course.

DISEASES.—Disease affecting the optic nerves or tracts produces symptoms that can be examined by different clinical methods, viz.:—

(1) *By testing vision.*—This test includes the examination of central and peripheral vision for form, colour, and light appreciation.

(2) *By examining the action of the pupil to light.*

(3) *By observation with the ophthalmoscope.*

In every case where optic nerve disease is looked for, all these methods must be employed. It will be sufficient here to mention that, in acute inflammatory conditions dependent upon intracranial disease, the ophthalmoscopic observation is the most important, while the visual test is particularly valuable in the early stages of implication of the nerve behind the eyeball of local origin.

General Pathology.—The optic nerve is peculiarly prone to suffer in affections of the central nervous system, in some forms of poisoning, and in certain general disorders. Inflammation of an acute or chronic character may attack it at any point in its course, may affect its whole thickness or only a part of it, and may or may not lead to permanent atrophy, total or partial. Again, without recognised inflammation, the nerve may undergo degenerative changes resulting in a simple atrophy. Occasionally the occurrence of an inflammation or simple atrophy of the nerve is intelligible enough, as, *e.g.*, an optic neuritis in association with orbital cellulitis, or a simple atrophy subsequent to division of the nerve-trunk. Frequently, however, the pathological process is difficult to trace, and our knowledge still rests largely on hypothesis. It is impossible in the space at our disposal, and would be of doubtful benefit, to enter into discussions as to the causal relation between optic neuritis and intracranial disease, etc.; but the following facts should be remembered in connection with the exceptional vulnerability of this nerve:—

1. *From its development and structure the optic nerve is to be regarded as part of the central nervous system.*

This serves to explain its liability to degenerative changes, similar to those occurring in certain strands and fibres in the brain and spinal cord, in post-tertiary syphilis (tabetic atrophy), and to those occurring irregularly in disseminated sclerosis; and probably, also, this similarity of nerve-tissue is responsible for the occasional association of optic neuritis with acute myelitis, due presumably to the selective action of some toxine on these parts of the central nervous system.

2. *The sheaths of the nerve are direct prolongations of the cerebral meninges.*

We thus have the liability to a direct transmission of inflammation of the meninges along the nerve-sheaths to the fibrous framework of the nerve itself, which latter may be thus attacked in any part of its course, but particularly at the lamina cribrosa, and at the entrance of the blood-vessels.

3. *The intervaginal spaces of the nerve are continuous with the meningeal cavities of the brain.*

In as far as these intervaginal spaces are also connected with each other, and with the lymphatic spaces surrounding the nerve-fibre bundles, it is obvious that fluid circulating in the lymphatic system of the nerve may contain inflammatory material primarily derived from within the cranium.

Again, serous fluid or blood effused into the meningeal cavities may find its way into the sheath-spaces and injure the nerve by direct pressure.

4. *The absence of primitive sheath probably renders the nerve-fibres more vulnerable in the retro-ocular portion; while, in the intraocular part of the nerve, the naked axis-cylinders are directly exposed to the action of the surrounding fluid.*

5. *It must be borne in mind that we can detect inflammatory and atrophic changes in this nerve such as might readily escape notice in other cranial nerves.*

Of less exceptional significance, but still important in considering the great vulnerability of the optic nerve, we would also mention :—

6. Their position, relation, and long course along the base of the brain render the nerves, commissure, and tracts liable to be affected in inflammation of the basal membranes, and to be damaged locally by pressure from new growths or from a distended third ventricle.

7. After entering the optic canal the nerve has for the rest of its course all the exposures of a peripheral nerve.

8. The narrowness of the optic canal must cause further constriction in an already existent œdema; and the disposition of the lamina cribrosa and of the nerve-sheaths where pierced by the central vessels will promote a similar effect by pressure on the blood-vessels and lymphatics.

INFLAMMATION OF THE OPTIC NERVE.—The expression "optic neuritis" is the generic term for inflammation of any part of the optic nerve. When the intraocular end of the nerve or papilla is inflamed, the condition is called "papillitis"; while "retro-ocular neuritis" implies inflammation of the nerve behind the eyeball, without implication (at first at least) of the papilla. The terms "axial neuritis" and "perineuritis" are used to denote the parts of the nerve involved, such as would be seen as presented on cross section.

As a rule both nerves are affected, and similarly, though not necessarily to the same degree, nor exactly at the same time. *Unilateral* optic neuritis is generally dependent on a local cause, such, *e.g.* as orbital cellulitis; but it may also occur in association with intracranial lesion.

Symptoms.—Optic neuritis may exist without there being any subjective symptoms directly indicating its presence—ocular pain, photophobia, and impairment of vision being alike absent. Photophobia, indeed, is rarely found as an accompaniment, and is never a prominent feature. Deep-seated pain in the orbit, and tenderness on pressure over the globe or on eye movement, are practically present only when the nerve is involved in an inflammatory condition affecting the orbital tissue surrounding the nerve. Vision may remain perfect for some time; indeed, in exceptional cases, papillitis from intracranial disease (gumma, for example) may occur, remain for some weeks, and disappear again, without sight ever being impaired.

Usually, however, failure of vision is a prominent symptom. This sometimes progresses rapidly, but blindness never occurs suddenly and remains permanently; although short, temporary attacks of darkness are not very uncommon in papillitis due to brain tumour.

It must be borne in mind that amblyopia occurring in a case of papillitis may be due, not to the neuritis, but to direct pressure of a tumour on nerve, chiasma, or some more central part of the visual tracts. The nature of the amblyopia (uniocular failure, bi-temporal loss of field, or homonymous hemianopia) will suggest this explanation, besides indicating the part involved, and may thus be of great localising value.

As a rule, in *papillitis* the failure of vision is gradual, slowly affecting central vision (especially at first for green and red), with progressive peripheral, sectorial, or irregular contraction of the visual field. Sometimes a neuritic sector-defect is binocular, simulating hemianopia of intracranial origin.

In *retro-ocular neuritis* the loss of vision is often rapid, and occurs mainly in the form of a central scotoma, at first only or mainly for green and red, later for all light (absolute scotoma). In acute cases of this kind there may be great amblyopia without any ophthalmoscopic change; indeed, in such cases the papilla is usually first involved when the severity of the attack is passing off and vision has begun to improve. This form is not infrequently one-sided, and the complaint of great loss of vision, while the optic disc appears normal, may excite the suspicion of malingering or of (so-called) hysterical amblyopia. In such a case of doubt an examination of the pupillary reaction will clear up the diagnosis; if the pupil of the (query) amblyopic eye fails to react as well as the other to direct stimulation by light, but acts perfectly consensually, we may rely upon there being some affection of the optic nerve to account for the blindness, although there is no other objective evidence of it.

Ophthalmoscopic Changes.—In well-marked papillitis the following appearances are found:—The edge of the optic disc is quite hidden from view, and the retina for some distance around is rather pale and cloudy. The general vascularity of the disc is much increased, while a greyish haze dulls its deeper details and obliterates the physiological cup. The whole papilla is swollen, so as to be considerably above the level of the adjoining retina, and many fine straight vessels may be seen radiating from it on every side, coursing over the obscured edge. The large retinal vessels, particularly the arteries, are often hidden at their exit on the papilla, and also here and there in their course over or just beyond it. The veins are enlarged, dark, and tortuous, showing evidently an obstructed venous flow. The arteries are normal or slightly narrowed. On the disc or in the adjoining retina hæmorrhages are often present, and sometimes also smooth, opaque, white spots.

In the slighter forms there may be merely some increased redness, doubtful swelling of the disc, with obscuration of the edge (particularly above and below), and distended veins.

Between these extremes there are many gradations observable in different cases, marked by more or less swelling and obscuration of details. These different degrees may simply be stages in the development of a gross papillitis, or any one may be the height of the affection where the papillitis is of less severity.

In a rapid, intense papillitis or "choked disc," the chief visible changes in the papilla (swelling and increased vascularity) are probably due mainly or entirely to œdema with pressure on the central vein, and in such cases there are generally evidences of great increase of intracranial pressure—intense headache with sickness. Should the intracranial pressure be relieved in such a case, the ophthalmoscopic signs quickly subside and leave no trace of their former presence.

As a rule, however, the progress of subsidence after papillitis is much more gradual, and of a less simple character. In such cases the redness of the papilla gradually disappears, while the swelling becomes reduced both in height and extent. The veins usually remain distended for some time, but ultimately all the vessels are narrowed. The edge of the disc again becomes visible, the outer margin coming first into view. The disc is opaque and woolly-looking at first, but gradually gets smoother; its surface is occupied by less or more newly-formed fibrous tissue, which often permanently conceals the lamina cribrosa. Around the disc there is frequently a pale zone, sometimes with scattered pigment granules, the result of changes in the retinal pigment layer. Should complete atrophy result, the disc is usually of a brilliantly white colour, and the larger vessels on or near it are often bordered by opaque white lines.

In cases of retro-ocular neuritis, the resulting pallor of the disc is sometimes the first ophthalmoscopic sign of the disease, but generally it is preceded by papillitis, which may be slight, moderate, or intense. The amount of resulting atrophy is usually comparatively slight, but varies much in degree. Not infrequently the pallor of the disc is greatly in excess of what we should expect from the excellent recovery of vision.

Rapid failure of vision, usually in one eye only, often accompanied by pain and tenderness in the neighbourhood, absence of early ophthalmoscopic changes, and a tendency to recovery, are the usual prominent clinical features in retro-ocular neuritis.

Under this head it has also been usual to class "toxic amblyopia," but there are strong reasons for the belief that the affection of the optic nerve in these cases is in reality secondary to changes in the large retinal ganglion cells at the macula (see "RETINA," p. 362).

Pathological Anatomy.—In papillitis of intracranial origin the evidences of inflammation seldom extend beyond the lamina cribrosa. The early stage of a severe papillitis is unaccompanied by affection of the connective tissue, the changes merely consisting of venous hyperæmia, infiltration, œdematous and ganglionic thickening of the axis-cylinders. Later, there is a new formation of œdematous connective tissue in the substance of the papilla, and filling the physiological pit, with an exudation of white cells; while behind the lamina cribrosa the medullary sheath of the nerve-fibres is swollen and undergoing granular degeneration. When the stage of subsidence with atrophy is reached, we find much connective tissue, partly of new formation, partly due to hypertrophy of the pre-existing framework; the nerve-fibre bundles are thus reduced in size from pressure, and either degenerated or quite disintegrated and replaced by hyaline material; the walls of the arteries are thickened, with consequent contraction of their lumen, tending to partial or total obliteration of the smaller vessels.

In retro-ocular neuritis the pathological changes doubtless vary greatly, according to the nature of the attack, while opportunities for examining the nerve during the acute stage seldom occur. The connective tissue of the septa has been observed to be thickened and vascular, with consequent pressure on the nerve-fibres. In later stages, when the inflammation subsides, the nerve-fibre meshes may either be restored, with relief of pressure and return of function, or they may be further narrowed with subsequent permanent atrophy of the contained nerve-fibres. The nerve is most liable to be attacked in the optic canal, or just behind the eyeball, and therefore the pathological changes are most marked in one or other of these localities. In either case it is the macular bundle that is mainly involved, thus accounting for the central scotoma clinically recognised.

Etiology.—The causes of optic neuritis may be divided broadly into two great classes, viz. those—

(1) *Of local influence, e.g.* orbital inflammation.
(2) *Of general influence, e.g.* renal disease and anæmia.

(1) *Local Causes.*—Under this heading are to be included cases of optic neuritis due to affections of the cranial bones, orbit, and cranial cavity.

(*a*) Of all the causes of optic neuritis *intracranial disease* is much the most frequent.

Any *tumour* within the cranium may produce papillitis, irrespective of its nature, position, or size; but it is most apt to occur when the tumour is of rapid growth, and when it is situated at or near the base of the brain or in the cerebellum. It is almost a universal rule that both nerves are affected, and generally the papillitis is gross, with considerable swelling. In very rare instances one nerve only is involved, but it is common to find a considerable difference in the degree of papillitis on the two sides. Where this difference is marked, it has been suggested that it may be of service in assisting to localise a tumour of unknown position, by indicating the side of the brain involved. Its actual value, however, is very problematical, for the fact of the one papilla being more affected than the other has no simple relation to the position of an intracranial growth, but is complicated by other anatomical considerations. The clinical evidence appears to show that in cases of tumour of the anterior half of the encephalon the papillitis is more marked on the same side as the growth (*i.e.* left greater papillitis, left-sided growth); while, when the tumour is situated more posteriorly, the nerve on the opposite side is the one more involved.

We also find papillitis in association with *meningitis* (especially traumatic, syphilitic, and tubercular basilar); with *cerebral abscess;* and sometimes with chronic cerebritis without gross lesion.

Injuries to the head may also cause swelling of the papilla, through effusion of blood within the skull or within the optic nerve-sheath.

(*b*) Optic neuritis due to *orbital disease* is nearly always one-sided, and of the retro-ocular kind.

The optic nerve may be attacked during an *orbital cellulitis,* arising from local injury, or by the extension of erysipelatous or other inflammation from adjacent parts. Sometimes an orbital cellulitis seems to follow exposure to cold. Occasionally a very severe form of cellulitis is associated with a general septicæmia, possibly through thrombosis of the ophthalmic veins.

Orbital periostitis accompanying local bone disease, or spreading from the upper jaw or nasal cavities, is liable to affect the optic nerve, probably by invading its outer sheath, where this and the periorbita are continuous at the optic foramen. To this class, doubtless, belong cases of alveolar abscess, where complaint has been made of tenderness extending up the cheek and into the orbit, with visual failure in this eye, and sometimes accompanied by slight prominence of the globe, and pain on pressure over it. Such an inflammation may readily gain the orbit by the spheno-maxillary fissure.

Orbital tumours, especially when situated near the nerve, may cause optic neuritis; but more usually they simply give rise to atrophy of the nerve by their pressure.

(*c*) In its passage through the *optic canal* the nerve is exposed not only to inflammation extending to it from the bony walls and the periosteum, but also from the *sphenoidal sinus,* only separated from the canal by a thin lamina of bone, sometimes imperfect. It is probable that many of the cases of retro-ocular neuritis traced to exposure to cold are examples of inflammation attacking the nerve in this part of its course, and sometimes in this way (through the sphenoidal sinus). In such cases both nerves are often affected, and almost simultaneously. Such cases of neuritis are not usually associated with early changes at the optic disc, but later there may be slight or moderate papillitis. The periosteum in this locality seems to be not infrequently the seat of gummatous deposit.

(*d*) Mention must also be made of the alleged occurrence of optic neuritis in connection with disease of the bones of the ear, without the usual intervention of meningitis or of cerebral abscess.

(*e*) The optic nerve itself may be the seat of a local manifestation of a general affection, as a syphilitic gumma or a tuberculous deposit. Again, the sheath of the nerve, possibly in any part of its course, but apparently most commonly near its junction with the sclerotic, is liable to be affected occasionally by inflammation of a gouty or rheumatic character; in many cases of this nature a marked tendency to recurrence has been observed. Papillitis is sometimes caused by an extension of inflammation from a neighbouring ocular tissue (*e.g.* gumma of the adjacent choroid), and it has also been observed in an early stage of sympathetic inflammation before the occurrence of irido-cyclitis.

Here also we may mention the not infrequent occurrence of retro-ocular neuritis in connection with insular sclerosis. In some of these cases the optic-nerve attack is like an ordinary acute retro-ocular neuritis, this nerve being the seat of a local lesion such as occurs disseminated elsewhere in the central nervous system.

Infrequently papillitis occurs in cases of myelitis, both chronic and acute. It is probable, as has been suggested by Gowers, that in such cases the optic neuritis and myelitis are independent, and both due to a common cause.

(2) *Causes of General Influence.*—Occasionally we get papillitis occurring alone in *renal disease*, but usually in such cases there is retinitis in combination with it. In *chlorosis*, or in progressive *pernicious anœmia*, we may meet with papillitis or papillo-retinitis, and also, more rarely, in *leucocythœmia.* In the *anœmia following* repeated large *loss of blood*, as from hæmatemesis, for example, papillitis has been observed, but more commonly we get retro-ocular neuritis or simple atrophy in this condition. Papillitis occasionally occurs in association with menstrual disturbances, such as sudden suppression or habitual irregularities.

Papillitis or retro-ocular neuritis is sometimes found in patients during or recovering from *acute febrile diseases* (typhus, scarlatina, measles, variola, enteric), in *malarial fever*, and also occasionally after *influenza.* In *diabetes mellitus* we may get loss of central vision of a similar character to what occurs in chronic poisoning by tobacco (also from lead, alcohol, and bisulphide of carbon). In as far as the macular fibres are alone or mainly involved in these cases, the visual failure has been ascribed to retro-ocular "axial" neuritis, but doubt has recently been thrown on this view, and the affection of the axial fibres is probably to be regarded as secondary to a poisoning of the retinal macular ganglion cells (see art. "RETINA"). In some acute instances of poisoning by these agents, however, slight papillitis has been observed.

In certain families we have an hereditary predisposition to suffer from a retro-ocular neuritis of a slowly progressive form, the nerve changes usually occurring about the age of twenty, and almost exclusively in males.

In most of these instances (*e.g.* anæmia, renal disease, fevers, etc.) the general influence causing optic neuritis is doubtless traceable to the presence of some poisonous material present in the blood, which has either a *direct* effect on the ganglion cells or their processes, or an *indirect* effect on these structures through its action on the nutrient blood-vessels.

Prognosis and Treatment.—The prognosis in all cases of optic neuritis must be a guarded one in reference to the final condition of the vision. The ophthalmoscopic appearances presented are of less service to us in this respect than a knowledge of the cause of the affection. We may have a papillitis with good vision leading ultimately to complete atrophy and blindness; while, on the other hand, we may have papillitis with the barest perception of light (as in occasional retro-ocular cases) followed by almost perfect recovery of sight.

In papillitis due to intracranial disease the prognosis depends mainly upon the effect of treatment on the exciting cause. In cases of syphilitic origin, accordingly, the outlook as to vision is relatively favourable, if the patient is subjected to an antisyphilitic general treatment before the stage of atrophy of the nerve has commenced. Even after the occurrence of partial failure of vision from this cause, there is often an arrest of the failure under treatment, and sometimes an actual recovery of vision. When due to intracranial tumours (other than gumma), the papillitis may be greatly benefited by the administration of iodide of potassium; and, in rare instances, it has been observed gradually to subside without visual loss even when the exciting cause was a malignant growth.

Surgical interference has certainly a decided influence in diminishing the prominence of the papilla in such cases, and that independently of there having been any attempt to remove the cerebral growth; the effect seems due merely to the reduction of intracranial pressure. This diminution of the papillary œdema gives the nerve an opportunity of recovery under treatment by iodides, but it is only in a comparatively early stage of papillitis that real benefit to the nerve can accrue in this way.

The value of surgical operation in cases of ear disease, and in all cases where pus is present within the cranium, lies chiefly, of course, in its effect upon the disease itself, and only secondarily in the benefit done to the accompanying optic neuritis.

In orbital disease, likewise, the treatment of the papillitis is determined by the nature of the affection. Pus in the orbit should be evacuated by early incision. In some few instances disease of the sphenoidal sinus has been diagnosed and treated surgically with good result.

Similarly, in papillitis due to general disease, the prognosis and treatment are dependent entirely on the nature of the disease in the particular case. Those cases of neuritis arising from intense anæmia (not pernicious) are very amenable to suitable medication and hygiene.

In retro-ocular neuritis of gouty or rheumatic nature, the treatment should consist in giving a mixture containing salicylate of soda and iodide of potassium, and in protecting the affected eye from cold. The prognosis in these cases is very favourable. Indeed, in most cases of acute retro-ocular neuritis recovery is to be expected, though not always complete; a central colour defect often remains long after the attack, even when visual acuity as tested in the usual way has been restored to normal.

In all cases of optic neuritis absolute rest of the eyes should be enjoined, though it is impossible to insist strongly upon it when the inflammation lasts (as it sometimes does) for many months. Exposure to bright light must be avoided by the wearing of dark neutral tint glasses.

ATROPHY OF THE OPTIC NERVE.—By the term "optic atrophy," when clinically employed, it will be understood that atrophy visible at the optic disc is meant. Pathologically considered, the optic nerve is always ultimately affected throughout its entire length in every form of atrophy, at whatever part of its course it may be first involved. Such an atrophy may either be *complete*, affecting the entire thickness of the nerve; or *partial*, when a smaller or larger number of the fibres escape; even in partial atrophy, however, the affected fibres are finally atrophic throughout their whole length.

Etiology.—Cases of optic atrophy are often divided broadly into two great classes, *inflammatory* and *non-inflammatory* or *simple*. Such a division is certainly most useful, but it groups so large a number of different forms of atrophy under a single heading that it is not of much etiological value.

We offer the following account of the different agencies that may produce optic atrophy, in the hope that it may prove serviceable in clinical classification:—

1. From inflammation of the nerve (consecutive atrophy).
   (*a*) Papillitis.
   (*b*) Retro-ocular neuritis.
2. From interruption in the continuity of the nerve-fibres in any part of their course.

(*a*) Section or rupture, as by wounds or other injuries.

(*b*) Destruction by inflammation, etc.

From the point of interruption atrophy extends along the involved fibres in both directions—peripherally and centrally.

3. From pressure.

(*a*) On the optic disc (glaucoma).

(*b*) On the nerve in the orbit (hæmorrhage into sheath).

(*c*) On the nerve in the optic canal (bony growths or fracture).

(*d*) On the intracranial optic nerve or chiasma (aneurysm, distended third ventricle, tumour of pituitary body).

4. From interference with blood-supply (*e.g.* in peri-papillitic choroidal atrophy).

5. Degeneration of fibres secondary to destruction, or impaired nutrition of ganglion cells.

(*a*) In atrophy of the retina (following total embolism or thrombosis of arteria centralis; in pigmentary degeneration of the retina, primary or secondary; in retinal detachment).

(*b*) In some cases of poisoning (as, *e.g.*, tobacco and bisulphide of carbon; the macular cells and fibres are chiefly affected).

(*c*) From an inherited neuropathy. Possibly the family cases known as Leber's atrophy may come under this heading.

6. Simple degeneration or true primary atrophy. This form frequently occurs in association with disease of the central nervous system, especially with tabes, but occasionally also with cerebral atrophy, mania, general paralysis of the insane, congenital idiocy, and primary lateral sclerosis of the cord. When found uncomplicated with other nerve lesion, the remote causes assigned are the same as those which are given for the occurrence of grey degeneration in the central nervous system; and it would therefore seem probable that, due to the action of certain causes, grey degeneration may occur independently in the brain, spinal cord, or optic nerves, and may be confined to one or other of these situations. Accordingly, we find male adults of the neuropathic disposition, from thirty to fifty, predisposed to this form of atrophy. The more immediate causes mentioned are severe bodily fatigue and hardships, especially exposure to cold and insufficient nourishment, grief and anxiety, mental excitement and exhausting brain-work, irregular habits of life, sexual excess, etc. But the great predisposing cause, common to a large proportion, at least, of these cases of grey degeneration, is syphilis. The effect is attributed to the action of a toxine developed in the post-tertiary stage of this disease.

Pathology.—The nervous elements of the trunk of the nerve are involved in all cases of optic atrophy, and, according to the number of fibres affected, there is a corresponding loss of function. The histological condition of the atrophied nerve varies somewhat, according to the nature of the initial pathological process, and dissimilar appearances may be presented in sections through different parts of the same nerve-trunk. Thus, in *atrophy following a neuritis*, we find the usual post-inflammatory changes at the seat of the inflammation, while the remainder of the nerve may present the appearance found after a simple or non-inflammatory atrophic process. As previously mentioned, neuritis leads to hypertrophy of the interstitial connective tissue; the consequent contraction of the meshes in which the nerve-fibre bundles lie, subjects the latter to pressure, interfering at first with their function, and ultimately with their structural integrity. The nerve-fibres involved either finally break down and are removed, or they undergo grey degeneration; in the former case the diameter of the nerve is much reduced. In the case of a neuritis, at or near the intraocular end of the nerve, the walls of the central blood-vessels are thickened and their lumen is diminished—partly in consequence of this change in their walls, partly from the pressure exerted by the hypertrophied connective tissue surrounding them.

In *simple atrophy* there is seldom much increase of connective tissue. The nerve-fibres lose their medullary sheath by a process of granular fatty degeneration, while the axis-cylinders are usually retained, but converted into fine indistinct fibrils. There is, consequently, little change in the size of the nerve, which has the appearance of a translucent, grey, gelatinous-looking cord. This "grey degeneration," as it is called, is the most common form of simple atrophy. Occasionally we do find considerable thickening of the connective-tissue framework, which may presumably be due, either to a primary sclerosis of a low chronic inflammatory nature, or to a hyperplasia of connective tissue secondary to degeneration and shrinking of the nerve-fibres.

In the great majority of cases both nerves are affected, though one may be considerably in advance of the other. Unilateral optic atrophy is to be explained by the one-sided nature of the preceding inflammation or other local cause.

Symptoms.—The prominent symptom in every case of optic atrophy is failure of vision. The occurrence of this failure is usually gradual, but varies greatly in rapidity in different forms and different cases. There is also much variation in the manner in which the field is affected. An examination of the central vision by test-types is necessarily of great practical importance, but the character of the loss—as regards the visual field, colour-perception, and light-sense—is often of greater value in judging of the causation and in forming a prognosis (see articles "AMBLYOPIA," "VISUAL FIELDS").

The nature of the visual failure in cases of atrophy secondary to neuritis has already been described. In atrophy from chronic retinal degeneration, the failure is usually gradual, central vision often remaining acute after the rest of the field has been lost.

In atrophy due to pressure upon the nerve-fibres behind the eyeball vision often fails suddenly. In other cases the failure is gradual and partial, and sometimes only the temporal half of the visual field is lost in each eye (as in pressure on the posterior part of the chiasma from tumour of the pituitary body).

In simple primary atrophy the loss of vision begins insidiously, and proceeds slowly and continuously, but may, in exceptional cases, come to a standstill while moderately useful vision still remains. Besides the central failure, there is marked contraction of the visual field, sometimes occurring in a uniform concentric manner, but more frequently in a less regular way so as to cause sector-shaped defects. Affection of the colour-sense is almost constant, green being the colour first confused, while later perception fails for red, blue, and, lastly, yellow. In the final stage of atrophy all colour distinctions are lost; but there is no constant relation between the degree of the loss of colour-sense and the amount of the amblyopia.

The condition of the *pupils* at rest should be noted in all cases. They are usually wide in atrophy following neuritis, small in tabetic cases, and either wide or of medium size in other forms. In tabes and in general paralysis the pupils are often unequal in size. If any vision remains the behaviour of the pupils to light is of importance; in tabes they are inactive, while still contracting well when the eyes converge in looking at a near object (Argyll-Robertson pupil). In other forms of atrophy, so long as vision remains, the pupil continues to show a response to light (see article "PUPIL").

Ophthalmoscopic Appearances.—The elements of the optic disc which undergo the atrophic change are the nerve-fibres and the capillaries. Atrophy of the capillaries causes pallor, while the nerve-fibre atrophy is ophthalmoscopically recognisable only when an atrophic excavation exists. This latter, however, is often absent, since the space formerly occupied by the intact nerve-fibres may be filled, or more than filled, by new connective tissue.

We judge of the optic atrophy chiefly, therefore, by the *colour*, but caution must be exercised in the observation, as the disc varies considerably in this respect in different individuals within physiological limits. It is particularly unsafe to diagnose pathological pallor of part of the disc unless the vision be correspondingly affected.

The *excavation* in atrophy comes quite up to the margin of the disc all round, and is recognisable by a slight change in the level of the vessels, and sometimes by their altered course at the edge of the disc. The atrophic excavation is never very deep, and slopes gradually backwards from the margin, so that the condition may fitly be termed "saucering," in contradistinction to the deep, steep-sided "cupping" found in chronic glaucoma (see article "GLAUCOMA"). The occurrence and depth of an atrophic excavation are determined—(*a*) by the size and form of a formerly existing physiological pit; (*b*) by the degree of loss of nerve substance; (*c*) by the amount of new connective tissue formed, and by the contraction which has taken place in this latter. At the bottom of the "saucer" the lamina cribrosa may be visible over a large area, or it may be quite concealed by the newly-formed tissue. The central retinal blood-vessels are in some cases much diminished in size; in other cases only very slightly, if at all.

In the form of atrophy occurring after *papillitis* the disc is usually white; its margin is visible, but often ragged-looking from irregular distribution of pigment in the immediately surrounding retina; the central vessels are frequently bordered by opaque white lines, and are considerably reduced in size (particularly the arteries); the excavation is absent or slight, and the lamina cribrosa is invisible.

In what is known as *simple atrophy* the disc has a different appearance. It is markedly pale, but seldom so white as in the last form, while the lamina cribrosa is conspicuous over a great part of its surface; the margin is clear and very distinct, without surrounding pigmentary disturbance; the central vessels are normal in size and character, or slightly reduced in size; the atrophic excavation is marked. This condition follows in all cases in which the disc becomes atrophied secondarily to an affection of the nerve quite behind the eyeball—as from gross retro-ocular neuritis, wound, or pressure. More rarely this form of simple atrophy succeeds a papillitis, probably indicating that the actual atrophic process in the disc was not produced by the severity of the changes there, but occurred secondarily from an inflammation that had its greatest intensity behind the globe. In simple degeneration the disc-changes are also usually of this character; not uncommonly in tabes, however, there is less distinctness of the lamina cribrosa than above described.

In the atrophy consequent on choroido-retinal changes, the disc has generally a peculiar opaque, pale, yellowish-pink, "waxy" appearance, and the retinal vessels are greatly diminished in size and sometimes in number.

In the partial atrophy produced by milder forms of retro-ocular neuritis, and in those due to the action of poisons (*e.g.* tobacco), the pallor is often confined to the temporal half or third of the disc, and this appearance frequently persists after recovery of function.

Prognosis.—The visual prognosis is generally unfavourable in all forms of true optic atrophy. In exceptional cases of atrophy following papillitis, considerable improvement takes place, when the sclerosing process does not lead to excessive pressure on such nerve-fibres as have escaped destruction by the inflammation. In some examples of retro-ocular neuritis followed by an atrophied appearance of the disc, there is a wonderfully complete restoration of vision; in such cases the atrophy has mainly or entirely attacked the capillaries on the disc, the nerve-fibres having escaped permanent damage.

In primary atrophy, almost complete blindness usually occurs in from one to three years; but in some instances the atrophic process stops, while moderately useful vision still remains. If, along with a slight progressive contraction of visual field, there is a rapid contraction of the field for colour, the prognosis is unfavourable. The presence of relatively good vision, with advanced ophthalmoscopic signs of atrophy, is a favourable sign.

Treatment.—Optic nerve-fibres when once destroyed are never restored, and the function formerly performed by such fibres cannot be regained. All that can be expected from treatment, therefore, is the preservation of fibres that, though threatened, are as yet intact; this preservation may be permanent or only temporary—a mere postponement or retardation of the destructive process.

In atrophy due to a neuritis the treatment is directed to the inflammatory process, and has already been considered.

In other cases our first endeavour must be to discover the cause. When the atrophy is dependent on some recognised general condition or toxic influence, the treatment must be regulated accordingly. In all forms of atrophy it is most important to prevent, as far as possible, all depressing influences on mind and body. Good food, healthy exercise, and cheerful surroundings will constitute valuable aids to any other remedial measures. Subcutaneous injections of strychnine are worthy of a trial. Absolute rest of the eyes, except in inflammatory forms, is unnecessary. Moderate use is, if not actually beneficial, certainly not apparently hurtful; and if the atrophy is progressive, and vision doomed to fail in any case, it is surely cruel to prematurely deprive the patient of all use of whatever vision remains. Appropriate glasses should be given to correct any error of refraction, and sometimes to magnify near objects. There must be strict limitation, however, of all finer work, such as reading; a sense of fatigue, or increased difficulty in seeing smaller objects, should be regarded as an evidence of the need for a temporary rest. Galvanism has been tried, but with doubtful benefit; though it is not, we believe, actually hurtful (as has been asserted), its use cannot be recommended.

INJURIES TO THE OPTIC NERVE.—The optic nerve may be injured in any part of its course, either as the result of a blow, stab, gunshot wound, or fracture of the sphenoid bone. A stab or thrust into the orbit may (without injury to the eyeball) cut or tear the nerve; or may merely bruise it, or cause an extravasation of blood within its sheath; or again, without actually injuring the nerve, may sever the central vessels outside its trunk. If a foreign body penetrate deeply it may fracture the orbital wall near the apex, and thus secondarily lead to injury of the nerve by a displaced bony fragment. Similarly, gunshot wounds may implicate the nerve either in its orbital or intracranial course. Sometimes the intraocular end of the nerve is injured by a fragment of metal that has penetrated the eyeball. Fracture of the base of the skull, as from a fall or severe blow on the head, sometimes causes injury to the nerve at the optic foramen, or behind it.

Sudden complete blindness of the corresponding eye is usually the immediate result of any severe injury to the optic nerve. If the solution of continuity be complete, permanent blindness is the consequence; if incomplete, there may be restoration of vision in part of the field. When the nerve is simply bruised, or pressed upon by extravasation within the sheath, sight may be restored; usually, however, secondary changes afterwards occur, leading ultimately to complete or partial atrophy.

The *ophthalmoscopic appearances* are usually at first of a normal character, but as the atrophic process reaches the disc, it gradually assumes the appearance of an ordinary simple atrophy. If, however, the central artery be cut or torn across, we at once find changes in the fundus similar to those met with in embolism of this vessel.

The *treatment* of the recent injury must be based on general surgical principles. Later, if the continuity of the nerve has been preserved, the measures recommended above in optic atrophy may be tried.

Tumours of the Optic Nerve.—The optic nerve trunk (including its pial sheath) may be the original seat of a tumour. It may also be involved secondarily by the extension of growths arising (*a*) within the eyeball (from retina and choroid); (*b*) in its dural sheath; (*c*) or in the surrounding orbital tissue.

When the nerve is primarily involved by a new growth, there is little or no pain, and the movements of the globe are usually good; but there is early failure of vision, papillitis or optic atrophy, and later proptosis. The most common form of such a tumour is myxo-sarcoma.

Of intraocular growths secondarily affecting the nerve, we must mention retinal glioma and sarcoma of the choroid: the former extends in the medullary substance of the nerve, the latter spreads along the sheath and fibrous framework.

At the optic disc there is occasionally seen a projection of small, pearl-like bodies, of the nature of the "corpora amylacea" found elsewhere in the central nervous system, and not necessarily connected with any visual loss. Gummata seem particularly apt to involve the optic nerve fibres in the optic canal and at the chiasma; in the latter situation, also, deposits of cheesy, tuberculous material are sometimes found.

Congenital Abnormalities.—Imperfect closure of the cleft in the embryonic optic cup and pedicle leads to coloboma of the iris, choroid, or optic nerve-sheath, according to the part and amount involved. This latter —coloboma of the sheath of the optic nerve—is comparatively rare. When it occurs, the main branches of the central vessels are seen to emerge near the upper edge of the disc-area, while the lower part of the latter, corresponding to the cleft in the sheath, is very pale and deeply excavated, with small vessels curving round its margins. The appearances vary considerably in different cases, and the condition is generally accompanied by coloboma of the neighbouring part of the choroid below.

The Retina

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Anatomy.—The retina is to be regarded as a distinct offshoot from the central nervous system, in which structural adaptations have occurred necessary for its special function of being stimulated by waves of light. The stimuli so produced —which vary in character according to the length and height of the waves—it is also capable of transmitting to the brain, by means of the elongated processes of its ganglion cells, familiarly known as optic-nerve fibres.

It will be sufficient for our present purposes to describe the anatomy of the retina very briefly. It consists of two distinct parts—*pigment-epithelium* and *retina proper*. The former lies immediately on and is closely attached to the inner surface of the choroid, and is formed by a single layer of large pigmented cells; in these cells subtle changes, probably mainly chemical in nature, are produced under the influence of light. The retina proper lines the greater part of the interior of the eyeball, beginning a little behind the ciliary body and reaching to the optic disc: it is made up of several layers—nerve-epithelium, nerve-cells, and nerve-fibres—held together by a supporting framework of delicate connective tissue. The nerve-epithelium is in contact with and slightly embedded in the pigment-epithelium; the absence of any true structural union between these two epithelial layers renders a separation liable to occur under certain circumstances. On the inner surface of the retina are the nerve-fibres, which converge and meet at the disc. Between these surface layers are numerous nerve-cells and their processes. The most important of these next the fibre layers are large ganglion cells, whose greatly elongated central processes (axons) constitute the fibres just mentioned in the retina, and then run and are continued by the optic nerves and tracts to gain the basal ganglia of the brain. The larger blood-vessels of the retina lie near its inner surface, while the smaller branches run both in the inner and middle retinal layers, but none enter the nerve-epithelium. The arteries do not anastomose with one another, nor is there any communication between these vessels and those of neighbouring structures after leaving the disc, so that the retinal circulation is terminal. Near the centre of the retina (to the outer side of the disc) is a small spot called the *fovea centralis*, where the epithelial layers (pigment and nerve epithelium) are alone present.

OPHTHALMOSCOPIC APPEARANCES. — On ophthalmoscopic examination, the normal retina, apart from its blood-vessels, is practically invisible, as it does not manifestly interfere with the passage of light to and from the chorio-capillaris. It is not *quite* transparent, however, and we can usually detect the presence of the retinal pigment as a very fine, dark stippling, visible on the red fundus when the pigment is very well developed. In persons of dark complexion, and particularly in dark races, the red fundus reflex is very decidedly obscured; while this reflex is particularly bright in light-complexioned people, on account of the small amount of pigment present. About two disc-diameters to the temporal side of the disc, the "yellow spot" region is recognisable by its darker shade of red, destitute of visible blood-vessels; near the centre of this area is a small brighter spot, marking the position of the fovea centralis. The retinal blood-vessels should be carefully studied in normal eyes, particularly in young people. We should note the relative colour and size, and the character of the central light-streak in the arteries and veins. It will be observed that both sets of vessels usually branch dichotomously.

DISEASES OF THE RETINA can only be detected by ophthalmoscopic examination. As already mentioned, the retina, with the exception of its blood-vessels and its pigment-epithelium, is almost quite transparent, and is therefore practically invisible ophthalmoscopically. Its diseased conditions are recognised, accordingly, by *changes in its blood-vessels* or *in its pigment-epithelium*, or by a *loss of its normal transparency*. The loss of transparency may be general or localised, sharply limited or diffuse, and such opacities may vary greatly in shape, size, and colour; we may mention as examples, retinal œdema, hæmorrhages, and inflammatory exudations.

CHANGES IN RETINAL BLOOD-VESSELS. — Disturbances in the retinal circulation may be shown by changes in the size and course of the vessels, in the appearance of their walls, and by a visible pulsation. In estimating the *size* of the retinal vessels we regard chiefly the larger branches on and near the optic disc, comparing them with our mental impression of those in an average normal eye. The departure from normal may apply to all the vessels, or to the arteries or veins alone; or it may only be observed in one or two branches; or again, the same vessel may show an irregularity in its calibre at different points. On making observations on the relative size of the arteries and veins, it is to be remembered that the normal artery has a diameter of about two-thirds that of the corresponding vein. By the direct method of observation the vessels will appear larger in the myopic and somewhat smaller in the hypermetropic eye, while by the indirect method an opposite effect will be produced. An erroneous estimation of size may also be caused by failing to note an abnormal rate of subdivision—the earlier the branching occurs the smaller the individual vessels will be at a given distance from the centre of the disc.

(1) A *general enlargement* of the retinal vessels, with an unusually dark blood-column, is present in congenital defects of the heart with cyanosis. The retinal vessels are also found somewhat distended in extreme cases of Graves' disease. A *general reduction* in the size of the vessels is occasionally present in marked anæmia and in renal disease; it is particularly conspicuous in cases of chronic retinal atrophy.

(2) The *arteries alone may be small* in cases of optic neuritis (late stages), of embolism, arterial thrombosis, and of quinine poisoning; occasionally also in general anæmia (*e.g.* after great hæmorrhage), where the veins appear normal, or even large from being flattened, owing to their reduced intravascular tension. Rarely, the arteries are temporarily reduced in size from spasm of their walls.

(3) In *venous distension* these vessels are large, rounded, abnormally dark, and tortuous. This condition may be dependent on local or general interference with the venous blood-flow. When the cause is local the distension is sometimes very great, and hæmorrhages are common. Among local causes may be mentioned optic neuritis, venous thrombosis, and pressure exerted by a diseased overlying retinal artery, as the most common. The retinal veins may be distended as part of a general venous congestion in the head, from pressure on the great veins of the neck. Again, the retinal congestion may be part of a general venous distension, either temporarily, as from coughing or straining at stool; or continuously, as in mitral disease and pulmonary emphysema.

(4) Occasionally we find irregularity in the size of both arteries and veins in different parts of their course over the retina. For example, an arterial branch of normal size near the disc may soon quickly dwindle without having given off any branch meanwhile; on tracing it farther out, this vessel, or one of its subdivisions, again swells out to its normal calibre, or even larger. In the same fundus the veins will usually also exhibit marked irregularities in size where crossed over by arteries, an interruption seemingly taking place at this point, and the vein being distended on the peripheral side of the crossing. In these cases there is hyaline degeneration with enlargement of the outer and middle arterial coats, and the pressure thus produced on the underlying thin-walled vein interferes with its blood-flow. The appearances described are usually associated with granular kidney (see later).

Increased tortuosity is more common in the veins than in the arteries of the retina. Such a course is always found in congested retinal veins. When in the plane of the retina the exaggerated tortuosity is easily observed; an antero-posterior curve also occurs, and is recognised by the vein being there darker than elsewhere, and by a local absence of the central light-streak.

The arteries are usually unduly tortuous when affected by the hyaline degeneration mentioned above.

In exceptional cases, normally sized vessels, both arteries and veins, show great tortuosity; this condition has been observed in connection with a liability to severe headaches in some hypermetropic persons.

Changes in the vascular walls are often recognisable with the ophthalmoscope:—

(1) A comparatively common form presents the appearance of distinct narrow white lines bounding each side of the red blood column. It is more frequent in the arteries than in the veins, and is then due to thicken-

ing of the adventitia, or to a deposit of white cells around the vessel. The perivascular lymph space of the veins may be the seat of a similar deposit. This vascular change often follows inflammation of the retina, as, for example, in the form accompanying papillitis, and is best seen on the larger vessels at and near the disc. But the same appearance may occur independently of any inflammation. Occasionally the entire breadth of the artery looks white, or there may be merely a narrow red line in the centre; yet in such a case there is no necessary loss of vision, since the lumen of the vessel may not be involved.

(2) In some cases the arteries have a much brighter reflex than usual, with a brilliant central light-streak. This appearance is usually accompanied by the other phenomena mentioned as characteristic of hyaline degeneration.

(3) Aneurysms may occur either on the larger branches of the central artery, or on the smaller twigs and capillaries of the retina. The latter are of clinical importance from their having been found associated with a similar condition of the small vessels in the brain.

Visible pulsation in one or more of the large *veins* on the disc is not uncommon in normal eyes; it is best seen just at the edge of the physiological pit. It also occurs, pathologically, from the same causes that produce *arterial pulsation.* This latter is never normally present, but occurs in aortic regurgitation, and in increased intraocular tension, whether from disease, or mechanically produced, as by finger-pressure from without. It has also been observed in acute anæmia from profuse hæmorrhage. Arterial pulsation is usually visible only in the large vessels on the disc, but in aortic cases it may sometimes be traced peripherally in branches of comparatively small size.

A peculiar form of visible circulation in both arteries and veins is seen not infrequently in recent embolism of the arteria centralis (see later).

ABNORMALITIES IN THE PIGMENT OF THE RETINA.—A congenital deficiency of this pigment is general over the entire fundus, and is familiar to us in partial or complete albinism. Pathological changes also frequently take place in this layer. Over a greater or less fundus area the pigment may be removed from its normal situation, and we thereupon get an unusual reflex, differing in character according to the degree in which the choroidal tissues have participated in the pathological change. Pigment so disturbed may be visible as a diffuse, coarse peppering over the red fundus-reflex, or it may be collected in larger masses of various forms over the denuded area, or again aggregated in the form of a fairly regular ring surrounding the affected patch. Such pigmentary changes are usually rightly considered along with their associated choroidal diseases, but one particular form (retinitis pigmentosa) will receive our attention in this article when we come to consider atrophic changes in the retina.

Occasionally, in persons beyond middle life, we see numerous round, yellowish-white, translucent spots of small size, bordered with pigment. They may be found in any part of the fundus, but are particularly common in the macular region and in the extreme periphery. They are due to the presence of small colloid bodies projecting into the retina, probably derived from the cells of the pigment-epithelium, and associated with an altered nutrition of this layer. When near the fovea they cause some disturbance of vision, but are not otherwise of clinical importance.

Apart from circulatory and pigmentary changes, we may recognise retinal affections by an interference with the normal transparency of the retina. Thus we may have diffuse haze from œdema, red patches from hæmorrhages, black deposits of pigment, or opaque white areas from exudation or from fatty changes. Again, the retina may be visibly raised from its normal position in the fundus as the result of an exudation or solid growth.

HÆMORRHAGES may occur in the retina at any part of the fundus, and are readily recognised, when recent, from their bright red colour. There may be only one, or they may be practically countless; and they may vary in size from a just visible spot or streak to a patch much larger than the optic disc. They are most common near the large vessels in the nerve-fibre layer, and then have a striated or flame-shaped appearance from the extravasated blood having passed between and run along the nerve-fibre bundles. Sometimes they occur from the fine vessels in the inner nuclear layer, and are then usually small and rounded in form. Occasionally a very large, sharply-defined hæmorrhage is found covering the macula; in this case the extravasation is more or less rounded, sometimes with a flat upper edge, and is situated between the hyaloid and internal limiting membranes. A large hæmorrhage often bursts through the hyaloid membrane into the vitreous, or sometimes passes backwards and causes detachment of the retina. Hæmorrhages interfere with sight according to their size and position; those mentioned as occurring at the macula necessarily cause loss of central vision, though in this case the prognosis is good. Very commonly their presence is of less visual importance, in so far as sight has been already impaired by the disease of the optic nerve or retina, of which the hæmorrhages are merely a result. Absorption takes place gradually, its rapidity being greatest in hæmorrhages of small size and in those unassociated with disease of the blood-vessels. There is often no trace ultimately left, or there may be a dark pigmentation or brilliant yellowish-white spots marking their former position.

Causes.—Hæmorrhages may be part of an inflammation of the retina or optic nerve, or they may be dependent directly on general conditions, or on retinal disease consequent on general conditions. The extravasation may be due to rupture of vessels or to diapedesis from a vein. The following statement will serve to show the possible manner of their occurrence:—

A. *Rupture of vessels* from—

(1) *Increased intravascular pressure*, local or general. (*a*) *Local*, *e.g.*, from contusion of the eyeball, or from great venous distension, as in venous thrombosis or other manner of interference with venous return. (*b*) *General*, as from cough, or other violent effort, and perhaps from high arterial tension, with or without hypertrophy of the left ventricle.

(2) *Sudden diminution of the vitreous support*, as in wound of the globe.

(3) *Weakness of a degenerated vascular wall*, as in sclerosis and miliary aneurysms of the retinal vessels, sometimes in embolism or thrombosis of the small arteries. Such vascular changes are usually concomitants of some general affection, such as cardiac or renal disease, or diabetes.

B. *Diapedesis* may be the result of—

(1) *Increased Intravenous Pressure.*—This is not always a direct effect; indeed, the retinal veins, on account of their capacity for becoming dilated and stretched, may resist for a long time. But this disturbance and slowing of venous flow leads to an œdema of the corresponding retinal area; and as the walls of the vessels in this area suffer in consequence (along with the other retinal tissues), they undergo degenerative changes, leading finally to diminished resistance to the passage of the red blood-cells through them. Hæmorrhages occurring in this way often remain near the vein from which the blood has escaped, but not invariably so. Not infrequently, when the veins are engorged and the retina œdematous, one or more hæmorrhages are seen lying alongside the corresponding artery. This position, however, is no evidence of the blood being arterial in origin; it is more

probable that it passes from the vein slowly along between the nerve-fibres, where there is least resistance, until it meets the obstruction caused by the body of the artery, and then spreads along its side.

(2) *An Altered Condition of the Blood.*—This is possibly the operative cause, in part at least, of the hæmorrhages found in cases of diabetes, severe anæmia, leucocythæmia, ague, purpura, scurvy, and pyæmia.

Retinal hæmorrhages, with tendency to recurrence, are occasionally met with in young people, particularly men, without any obvious cause. These hæmorrhages may be small and peripheral, and of small consequence; in other cases, or later in the same individuals, they are larger in size, often bursting through into the vitreous, and not seldom followed by detached retina and loss of sight.

The *treatment* of retinal hæmorrhage must necessarily vary with the general and local states with which it is associated or on which it depends. In recent cases of large hæmorrhage into the vitreous iced compresses may be applied over the eyelids.

INFLAMMATION OF THE RETINA is usually the result of some general disease, and the classification of its forms commonly adopted is clinical rather than pathological. When an inflammation commences in the retina, the papilla is generally secondarily involved; and, again, retinitis, mainly of the inner layers, is not infrequent in cases of papillitis.

The principal ophthalmoscopic evidences of retinitis are—loss of retinal transparency, dilatation of the veins, and a tendency to the occurrence of hæmorrhages and white patches. Sometimes there are numerous opacities in the vitreous. Anatomically, we find serous infiltration of the retina, inflammatory exudations, hæmorrhages in the inner or middle layers, fatty degenerations, swelling of the Müllerian fibres, and hypertrophy and sclerosis of nerve-fibres.

The impairment of vision, both temporary and permanent, varies much in different cases. The *treatment* must be regulated mainly by the general condition of the patient. Complete rest of the eyes must be enjoined, along with the use of dark, neutral tint glasses. Counter-irritants to the temple are occasionally beneficial.

HÆMORRHAGIC RETINITIS is serviceable as a clinical term in cases where we have numerous hæmorrhages along with evidence of retinal inflammation. It usually affects one eye only, and is seldom found before middle life is passed. The hæmorrhages are generally small and numerous, chiefly in the inner layers of the retina; they are sometimes widely distributed over the fundus, at other times confined to the distribution of one retinal vein. The papilla is hyperæmic, with blurred margins. There is diffuse opacity of the retina from œdema, which may be general or localised. All the veins may be very greatly distended, or there may be a less degree of fulness in only one large branch. We frequently find a few circumscribed white spots, and occasionally these assume the stellate distribution at the macula that is so common in renal retinitis.

Causes.—There are two types of this affection indicated in the above description, each probably with a distinct mode of occurrence.

(*a*) When the veins are very greatly distended, while the arteries appear normal, the operative cause is possibly a venous thrombosis. This may affect the vena centralis or one of its branches; in the latter case the venous engorgement, œdema, etc., are limited to the drainage area of the affected vessel. The reason for the occurrence of the thrombosis is generally obscure; there is usually, probably, a surrounding inflammation, implicating the vein secondarily.

(*b*) The veins are not much distended, and look normal generally on the disc itself.

The point of obstruction in the venous flow in such a case is usually ophthalmoscopically visible in one or more branches, and is then evidently due to the pressure exerted by an overlying retinal artery. The arteries present the appearances described above as characteristic of hyaline degeneration, the secondary and tertiary branches of the arteria centralis being particularly bright and "silver-wire" looking. Not infrequently we can, by tracing the obstructed vein towards the periphery, observe œdema and hæmorrhages in its area. The macula is sometimes involved in the œdema; we then usually find a few white spots in this situation, and occasionally these are arranged in rays diverging from the fovea (macular stellate figure); while exceptionally the extreme periphery of the macular neighbourhood is surrounded by a circle of white, irregular in breadth (circinate retinitis).

The œdema, hæmorrhages, white spots, etc., are secondary to the venous obstruction, which again is dependent on the arterial disease. This latter is, in the great majority of cases, if not always, only part of a widely-diffused arterial degeneration, which tends particularly to affect the minute arteries of the retina, pia mater, and kidney. Patients with this retinal condition are very often gouty, and they frequently give a history of having suffered from severe migraine. In all such cases the urine should be examined carefully and repeatedly for the presence of albumin; the particular form of renal disease associated with this condition is the granular kidney.

The local prognosis is unfavourable, though sight sometimes improves for a time. The general prognosis is also grave, in as far as there is a marked liability to the occurrence of cerebral thrombosis or hæmorrhage.

ALBUMINURIC RETINITIS is a term long in general use, to indicate a definite ophthalmoscopic picture of great clinical significance. It is characterised particularly by the presence of numerous soft-looking, light-coloured patches, and of small, opaque, sharply-cut, very white dots or striæ at the macula. The affection of the papilla varies between a mere slight congestion and a decided engorgement; in the latter case the veins are distended, and there is a marked tendency to hæmorrhages, which occur mainly in the nerve-fibre layer. The soft-edged light patches occur comparatively early, and are found mainly in the neighbourhood of the papilla; they are of rather large size, and usually lie behind the retinal vessels, but sometimes in front of them. The white punctate spots appear later, and are arranged in the form of a fan or star, the lines radiating from the fovea centralis. Both eyes are nearly always affected.

Causes.—This form of retinitis is most commonly associated with chronic disease of the kidney, especially the contracting granular form. It is also sometimes met with in acute nephritis after scarlatina, and is often present in the albuminuria of pregnancy, It must be remembered, however, that we may have a papillitis or papillo-retinitis, very like that from intracranial affections, in renal disease, without the typical appearance above described. On the other hand, retinitis of the albuminuric type, with stellate macular figure, etc., occurs exceptionally in connection with intracranial affections, diabetes, or anæmia, without there being evidence or other suspicion of renal disease. The most valuable factor in the ophthalmoscopic diagnosis in all doubtful cases is the condition of the retinal arteries; if these have undergone hyaline degeneration, renal disease is almost certainly present. This arterial change is, we believe, always present in the retinitis found along with the albuminuria of pregnancy, indicating that such patients are, in fact, the subjects of chronic renal disease, and that pregnancy has had a prejudicial effect on the malady.

Prognosis.—(*a*) Local.—If improvement takes place in the general condition or renal affection, the retinal changes may subside, but the changes at the macula persist for a long time even in the most favourable cases, *e.g.* those occurring after scarlatina and during pregnancy. In the last-mentioned group the prognosis is relatively more favourable if the retinitis has not occurred during any previous pregnancy, and if it occurs during the later months. Induction of premature labour is often advisable—always if the retinal condition is grave or getting rapidly worse.

(*b*) The prognosis as regards life is unfavourable in cases of albuminuric retinitis in chronic renal disease, except where pregnancy has been the determining factor, the subjects of it often dying within a year after the vision has become thus affected.

Syphilitic Retinitis.—This is usually an inflammation of a chronic diffuse type, without gross ophthalmoscopic changes. The retina becomes hazy and grey, especially near the papilla, at the macula, and along the larger vessels. The large veins are somewhat distended, and the outline of the papilla is blurred. White patches and hæmorrhages are rare. The vitreous often shows fine dust-like opacities close in front of the retina. Occasionally, on the inner surface of the retina, one or more white bands of exudation are formed, which afterwards are organised into connective tissue, and may ultimately occasion detachment of the retina. Choroiditis is often an accompaniment. The retinal affection usually comes on late in the secondary stage, often about the end of the first year, and is relatively more common in persons who have acquired syphilis rather late in life; it is also met with, however, in young children who have inherited the disease. It may occur in both eyes, or in one eye only. Later, the retina often shows atrophic changes, with pigmentation.

Course.—There is early visual failure, often with night-blindness, and sometimes micropsia. The retinitis lasts for months, with a tendency to occasional temporary improvement; the ultimate result is usually favourable if proper treatment is pursued. When atrophy and pigmentation result there is much permanent loss of vision.

Treatment.—It is impossible to insist too strongly on the necessity of early mercurial treatment, preferably by inunction. The *local* treatment of retinitis has already been described.

Leucocythæmic Retinitis.—Retinal changes not infrequently occur in the splenic form of leucocythæmia, and are then always present in both eyes, though often in an unequal degree. In a typical case of this affection there are retinal hæmorrhages of peculiar character, appearing as white patches surrounded by a red border; these are found particularly at the limits of the retinal circulation, viz. at the macula and at the periphery of the fundus. There are also ordinary hæmorrhages, usually of small size, and widespread retinal haze with blurring of the disc. The general fundus-reflex is of an orange-yellow colour; the retinal arteries are bright orange, and the veins broad, flattened, and of a light carmine tint.

Diabetic Retinitis.—Retinitis is not common in diabetes, but when it occurs is nearly always found in both eyes. There is seldom haze of the retina or change in the papilla. The most common form of this affection shows at first simply many small retinal hæmorrhages; but in some cases we have later rather large, flat-looking, white, opaque spots at the macula, with sharp, crenated borders. In other cases the appearances closely resemble those found in renal disease, but in these cases the arteries show hyaline degeneration with pressure on the veins, and granular kidney is probably present in addition.

Central retinitis from exposure to direct sunlight has been occasionally met with in persons who have looked at an eclipse of the sun without adequate protection. Immediately after the exposure there is some loss of central vision, in the form of a central scotoma. In very severe cases this remains permanent, but generally improvement slowly takes place. Ophthalmoscopically the macula is found to be more darkly pigmented than usual, with some large granular deposits near the fovea, which latter is visible as a greyish yellow spot. In severe cases with permanent scotoma there is probably some destruction of the outer segments of the cones, as well as change in the pigment epithelium.

The *treatment* should consist mainly in the use of dark glasses. Leeches or counter-irritants applied to the temple have been recommended.

CENTRAL RETINAL CHANGE IN INFANTS.—Mention must be made of this rare affection, which has important clinical and pathological relations. About the age of three or four months the child is noticed to be listless, with weakness of the muscles and apparently imperfect sight. The ophthalmoscope shows a dense grey, slightly raised opacity occupying the macular region, in the centre of which is a bright red spot—a condition like that found in embolism of the central artery. The disc may even now be pale, and becomes progressively more atrophic. Soon the child becomes quite blind, with pupils inactive to light; there is an apathetic state and partial muscular paralysis; finally, nourishment fails and death takes place about the age of two years. The ophthalmoscopic changes are always present in both eyes. The disease sometimes affects several members of a family. Pathologically, atrophic changes have been found in the neurones of the cerebral cortex, and presumably similar changes occur in those of the retina. No treatment is of any avail.

CENTRAL RETINAL AFFECTION FROM TOXIC INFLUENCE.—The particular form of visual failure known as *toxic amblyopia* has generally been considered under the diseases of the optic nerve, as the recognised changes in the fibres seemed to indicate that the affection was a variety of retro-ocular neuritis. Recent knowledge regarding the constitution of the neurone has rendered necessary a reconsideration of the hitherto accepted pathological nature of this particular affection of the nerve fibres, and there is good reason to believe that the large macular ganglion cells in the retina first suffer under certain toxic influences, and that the implication of their *axons* or nerve fibres is in reality secondary. There is no certain knowledge as to the exact manner in which the ganglion cells are thus affected—whether it be a direct poisonous influence communicated to them through the circulation, or whether the nutrient arteries are themselves first damaged by the poison conveyed in the blood.

Tobacco is by far the most common toxic agent in this disease, and the subjects are nearly all males at or beyond middle life. As a rule, these persons have used strong, coarse tobacco, and have either smoked or chewed (sometimes both) a comparatively large amount. In a considerable proportion of the cases there is a history of recent mental shock or worry, which probably predisposes the nervous system to suffer, but which also frequently induces a larger consumption of the drug. Other toxic agents, that either initiate similar effects, or predispose the nerve cells to suffer from tobacco, are lead, alcohol, and bisulphide of carbon. Diabetes, and perhaps also granular kidney, have a similar influence.

The visual failure is progressive, occurs in both eyes, and is most marked in bright lights. On examination, the defect is in the central part of the visual field, occupying the fixation area and a little to its outer side, where there is marked colour-blindness for green and red.

Ophthalmoscopic examination commonly shows slight pallor of the outer third of the disc. In some cases a few round, brightish yellow dots of moderate size are observed at the macula, but it is doubtful how far these are associated with the toxic changes, as similar dots are not uncommon in this region in persons with normal vision. In a very considerable number of cases—especially those occurring in oldish men when there is a delayed recovery of vision under treatment—evidences of hyaline degenerations of the retinal arteries is observable.

The *treatment* consists principally in an absolutely strict abstinence from tobacco in every form, and in avoiding any other influence that may be fairly judged detrimental. Good food and fresh air are important, and it is usual to give strychnine in small doses. Recovery of sight rarely commences for several weeks, but then as a rule proceeds rapidly and satisfactorily (see also "AMBLYOPIA," vol. i.)

RETINITIS PROLIFERANS is a term applied to an affection of the fundus, in which thick, white strands of connective tissue cover part of the retina, encroaching on the vitreous, with vessels of new formation visible over them. The condition is probably always due to the organisation of previous large retinal hæmorrhages.

RETINITIS PIGMENTOSA designates a disease in which a certain group of symptoms and a definite course are usually found in association with pigmentary changes in the retina. The term has long been in general use, and has been retained here on that account; but it must not be understood that this affection is inflammatory, and we will find that it may occur without the usual pigmentary changes. The change is properly a chronic progressive atrophy of the retina; it may occur either as a primary disease, or secondary to choroidal inflammation, and is generally, but not always, associated with peculiar deposits of pigment in the atrophied tissue.

The primary or idiopathic form of the disease is symmetrical and very slowly progressive, usually beginning in early life, and often terminating in blindness about the age of fifty. Night-blindness is the earliest and most characteristic symptom. There is next loss of visual field, generally first in the form of an annular scotoma, which broadens both outwards and inwards until a small central field alone remains. Central vision may remain good for a long time, but gradually deteriorates, and opacities forming at the posterior pole of the lens still further reduce the sight. The affection is often found in several members of the same family, and sometimes in successive generations. Consanguinity of parents is occasionally found, but it is doubtful if this is the direct cause even in these cases; this relationship may simply intensify an already existing predisposition. The true etiology is quite obscure.

Ophthalmoscopic examination shows, nearly always, much pigment in the retina, largely in its inner layers; here black masses, shaped somewhat like bone corpuscles, lie superficially to the level of the retinal blood-vessels. This pigmentary deposit is found chiefly in a belt midway between the centre and periphery of the fundus, and there is also thinning of the pigment layer, with probably atrophy of the chorio-capillaris, so that the deep choroidal vessels become clearly visible. No constant relation exists between the amount of pigment and the loss of sight; indeed, as has been already mentioned, we may have the usual symptoms and course of the disease without the presence of any abnormal pigment in the retina. What is visually of more importance is the extent in which the circulation of the retina suffers, and this varies considerably. In the worst cases there is marked diminution in the size of the retinal vessels, especially the arteries, which may be reduced to mere fine threads; and the disc shows an opaque, yellowish red, waxy atrophy.

Similar changes in the retina and optic nerves are found, not infrequently, secondary to choroidal inflammation; in such cases, of course, we have the atrophic changes in the choroid in addition, and usually of the disseminated type. When the retinal changes occur, primarily or secondarily, the clinical symptoms are the same.

Pathological examination of the retina shows an increase of the connective tissue framework, atrophy of the nervous elements, and thickening of the walls of the arteries. There is atrophy and disintegration of the pigment epithelium, and the retina proper is infiltrated with aggregations of pigment granules, thence derived. These travel forwards in the lymph channels of the retina, particularly those surrounding the retinal vessels, and collect in large conspicuous masses at the vascular branchings.

In a variety of the affection known as *retinitis punctata albescens* there is not only absence of the usual pigmentation, but there are numerous small white spots which are distributed fairly uniformly over the fundus, rather in excess at the periphery.

Treatment.—Galvanism is, we believe, the only form of treatment of any avail in retinitis pigmentosa. It sometimes causes a marked temporary improvement both in field and in central acuity. If it prove serviceable in any case it should be persevered with for some considerable time, and resorted to again when there is a renewed visual failure.

EMBOLISM AND THROMBOSIS OF THE CENTRAL ARTERY may be considered together, as they cause similar effects on vision, and are accompanied by identical retinal changes. The arteria centralis itself may be implicated, or one of its branches, and the obstruction may be complete or partial.

Embolism is the probable cause when there is cardiac disease, especially mitral, or atheroma of the aorta. It is more common in the left eye than in the right. When Bright's disease is present, and particularly when the retinal arteries show hyaline degeneration, *thrombosis* is to be suspected; not infrequently temporary attacks of loss of vision precede the permanent one. In complete obstruction of the artery, from either cause, the leading symptom is sudden blindness of the affected eye. There is sometimes a temporary improvement a few hours later, from the establishment of an imperfect collateral circulation at the disc, but the usual final result is absolute blindness. In obstruction of a branch the visual defect is generally partial from the first, the final result likewise being loss of vision corresponding to the distribution of the affected branch.

Ophthalmoscopic Appearances.—Within a few hours of the occurrence of obstruction the retina shows a diffuse milky opacity from œdema, best marked in the macula and the neighbourhood of the disc. In the centre of the opaque macula a bright red spot indicates the position of the fovea centralis, where the normal chorio-capillaris red reflex shines through the thin retinal epithelial layers, and appears exceptionally red by contrast with the surrounding cloudiness. The disc is pale, with soft, blurred edges. The arteries are much narrowed, and no pulsation can be evoked by pressure on the globe.

After a day or two the retinal arteries become broader again from partial refilling, and the blood in some cases is seen, both in the arteries and veins, in the form of short, detached columns separated by clear intervals; these columns move in a jerky fashion, with or against the normal direction of blood-flow. This visible circulation seldom lasts more than a day or so. Small hæmorrhages often occur near the disc.

Some days later the normal arterial pulsation on finger pressure may return in the larger branches, and the retinal œdema slowly disappears, but the nutritive supply of the retina has been too long interrupted for any restoration of function to take place, and the disc gradually becomes secondarily atrophic.

Where a branch only is affected, changes similar to the above are found confined to the area of its distribution.

Treatment is seldom of any avail in embolism, and then only within the first few hours. Our endeavours must be to break up and displace the arterial plug; and massage of the globe has in a few instances proved successful in effecting this. It is probably best performed by alternate, prolonged, moderately firm pressure on the globe and sudden removal of this pressure.

THROMBOSIS OF THE CENTRAL VEIN has been already discussed when speaking of *hæmorrhagic retinitis.*

DETACHMENT OF THE RETINA.—In this condition the retina proper is separated from the pigment epithelium, and the interval is usually occupied by a serous fluid. The retina is normally very loosely attached, except at the margin of the disc, and at the ora serrata. Fluid once present here readily gravitates to the lower part of the fundus, where detachments of old standing are most commonly found. Occasionally, instead of serous fluid, the displacing agent is an extravasation of blood, or a plastic exudation from choroiditis, or a solid choroidal tumour pushing the retina forward, or a subretinal cysticercus. The last mentioned is very rare in this country. Subretinal fluid may be effused, *primarily*, as a hæmorrhage, or as a serous exudation in connection with inflammation, renal disease, or tumour of the choroid. The common reason of detachment, however, is some alteration in the vitreous—either a mere diminution of its support to the retina, or contraction of connective-tissue formations within it, forcibly dragging and sometimes tearing the retina away from its normal position. In such cases the subretinal effusion of fluid is *secondary*, and either derived by transudation through the choroidal capillaries, or by direct passage through the retinal rent of fluid from the vitreous cavity.

Alterations in the vitreous provocative of detachment are well known to be often associated with myopia; they also occur from inflammation of the ciliary body and choroid. Perforating wounds of the sclerotic may lead to detachment, either immediately, from a loss of vitreous, or subsequently, from contraction of cicatricial tissue at the point of puncture. In many cases of detached retina no cause can be discovered.

Anatomically, the detached retina undergoes a gradual degeneration, the nervous elements being destroyed and its connective tissue hypertrophied.

Diagnosis.—The general appearance of the eye is usually normal. In cases of very extensive detachment the pupil acts imperfectly to light; the anterior chamber is deep, particularly at the base of the iris. The tension of the globe is usually decidedly diminished, but may be normal or even increased; the latter is suspicious of the presence of a choroidal new growth.

Central vision may or may not be much affected, according to the condition of the media and to how far the macula is implicated. The visual field will show a contraction corresponding to the extent of the detachment. But the accurate diagnosis of the disease depends upon the ophthalmoscopic examination. When we illuminate the patient's eye with the ophthalmoscopic mirror, held at about the distance of a foot, we have a want of the normal uniformity of reflex, part of the fundus corresponding to the detachment appearing bluish or light grey, in contrast to the normal red seen elsewhere. This discoloured, detached portion, is often folded and more or less tremulous, and the vessels are usually visible, even by this method of examination, appearing as dark, stiff-looking, tortuous lines. In the case of a recent shallow detachment the difference in reflex may not be easily noticeable, but the vessels have the characteristics just mentioned, though they are not so conspicuous, owing to the absence of the strong contrast furnished by the light-coloured surface. By the direct ophthalmoscopic method we now carefully measure the refraction of the vessels on the affected and unaffected parts of the retina, so as to, in difficult cases, finally determine whether a displacement of retina really exists. The vessels show no central light-streak. If detachment is present, estimate the difference of level between it and the normal fundus in its neighbourhood. Having thus satisfied ourselves of the detachment and measured the displacement, we next note its extent, the character of the boundaries, its mobility on movements of the eye, its colour, its variation in height, and the degree of folding. We are thus enabled to form an opinion as to the probable nature of the displacing agent—whether a rounded, solid growth; a low, flat, firm exudation; or a thin fluid. Occasionally, however, the presence of opacities in the media or iritic adhesions interfere with such an examination; under such conditions the indirect method of ophthalmoscopic observation is particularly valuable.

The discoloration of a detachment is due to opacity of the retina, produced largely by œdema; the darkness of the blood-vessels is accounted for partly by absence of the central light-streak, partly by contrast, but mainly by their being seen by transmitted light.

Symptoms and Cause.—There is often a history of a comparatively rapid impairment of vision; objects sometimes appearing distorted or as covered by a thick black veil. Sometimes we have complaints of quick flashes of light. As already mentioned, central vision may remain good for some time, but in a large number of cases the detachment gradually extends, and the sight becomes progressively worse, until ultimately there is complete blindness or only the barest perception of light. The lens often becomes opaque in the case of large detachments that have lasted for some time.

Treatment.—In recent cases of serous detachment we can often get satisfactory improvement of vision, for a time at least. But the necessary remedial measures are decidedly irksome, and even trying to the general health, if all the indications are strictly followed out. What we desire is absorption of the subretinal effusion. Rest, lying on the back, in a dimly lighted room is particularly to be insisted on for several weeks, and the eye should be kept covered with a moderately firm pressure bandage. All exertion or sudden effort must be avoided, and the bowels carefully regulated. Diaphoretics are recommended, and even purgatives, but such a course is necessarily very lowering, and the patient's general condition must not be forgotten in our desire to get a good local result.

In the case of detachment occurring in an only remaining eye, the importance of regaining vision is sufficiently great to warrant the above indicated line of treatment, and there is seldom any difficulty in persuading the patient to submit to it. When the detachment is large and evidently much distended by the subjacent fluid, puncture of the sclerotic at the site of the greatest displacement may be resorted to as a preliminary to other treatment.

When there is reason to believe that the detachment is due to a choroidal tumour, excision of the globe without delay is the proper course.

INJURIES OF THE RETINA.—Blows on the eye may cause hæmorrhage in the retina, or detachment. Occasionally, when the eyeball receives a direct blow about the middle of the cornea, the macular region is injured, and becomes œdematous or slightly detached, with local choroido-retinal changes. It is not uncommon for the eye after a contusion to be almost blind for a short time, the sight then returning to normal without any ophthalmoscopic change being visible (retinal concussion). In rare instances of this kind we find a localised milky-white cloudiness of the retina corresponding to the part at which the force of the blow was felt. This lasts for about three days and then disappears, and soon afterwards the vision usually is restored to normal (see also "EYEBALL, INJURIES OF," vol. iii.)

GLIOMA OF THE RETINA is essentially a disease of early childhood, and is usually met with at some time between infancy and the age of three years. It commences insidiously without pain or inflammation, and grows rapidly.

By its growth *forwards* it soon fills the eyeball, and then perforating the outer coats involves the other orbital tissues; finally, there is a very large, fleshy, readily bleeding protrusion from between the lids without any manifest trace of the globe. Backwards it extends along the optic nerve, and ultimately invades the brain. It not infrequently causes secondary deposits in the scalp, the neighbouring lymphatic glands, and sometimes in the liver and other distant parts. Death takes place from exhaustion or from implication of vital organs.

Occasionally it attacks both eyes independently. It sometimes occurs in several members of the same family.

Diagnosis.—Sometimes the child is brought at an early stage, because the attention of the mother or nurse has been aroused by seeing a whitish appearance from behind the pupil. At this time the eye is still quiet, looks natural, except for its white reflex, and has normal tension. In many cases the child is not brought until a later period, when redness and pain in the eye are observed; we now usually find the symptoms of secondary glaucoma—dilatation of the pupil, slight steaminess of cornea, engorged scleral veins, tenderness on light pressure, and increase of tension. By focal illumination we see a yellowish white, rounded, or lobulated solid-looking mass projecting into the vitreous, with blood-vessels visible on its surface, and occasionally small, white, chalky-looking bodies in the vitreous over it.

In some cases, especially in an early stage, it is simulated by inflammatory deposits occurring in the vitreous, due to suppurative choroiditis (pseudo-glioma). The tension of the eyeball in this affection, however, is never raised, and is usually found diminished. As all vision is lost, it is our duty, in every doubtful case, to deal with the eye as if it were a glioma.

Pathology.—The naked eye appearance is that of a soft, marrow-like growth of a whitish or reddish white colour, sometimes studded with small calcareous bodies; it is never pigmented. The tumour is composed of small cells, and the growth generally originates in the granular layers of the retina.

The *treatment* consists in early removal of the affected eyeball, dividing the optic nerve as far back as possible. If extra-ocular structures are already to some extent affected, it is advisable to thoroughly eviscerate the orbit, and apply chloride of zinc paste to the surface so left. If the tumour is very large its removal cannot be expected to save or even prolong life, and it is advisable to leave it alone. In such a case palliative medical treatment is all that can be done.

CONGENITAL ABNORMALITIES.—The absence of pigment in albinos has already been mentioned. For the appearance of the retina met with in coloboma of the choroid, we must refer to the account given of this latter condition (see art. "CHOROID," vol. ii.)

Not infrequently we find *small, round, black spots* on the fundus, usually few in number, and not interfering with normal vision. They have an appearance such as would be presented by tiny drops of black pigment flicked over the red fundus from a brush, and are due to localised aggregations of retinal epithelial pigment. In some cases, again, we may observe *very small bright dots* in the retina, chiefly in the neighbourhood of the optic disc. They can only be seen by the direct method, and are generally found near the large vessels in the optic disc neighbourhood, flashing into view and disappearing on small movements of the mirror, but always reappearing in the same position, and best seen near the edge of the image of the flame. Their presence is often accompanied by symptoms of asthenopia.

Opaque nerve fibres usually occur in the form of a wedge, having its blunt apex at the edge of the disc, and its base directed towards the equator of the eye. The affected area is brilliantly white, often rather fluffy in appearance, and the large retinal vessels are here almost, if not quite, concealed from view. It seldom reaches far peripherally, and generally ends in an irregular teased-out looking border. It is commonly situated above or below the disc, but may completely surround it. Exceptionally, the patch of opaque nerve fibres is situated at some distance from the disc, and separated from the latter by normal red fundus; it is then more brush-like in form, the inner end presenting an abrupt edge, while its equatorial end is here again broader and teased-out looking. The whiteness and opacity in all cases of this nature are due to the presence of a medullary sheath round the axis cylinders of the retinal nerve fibre layer. Normally, all these fibres gain this covering at the scleral opening, but exceptionally it is assumed earlier—in some few cases, as we have seen, to be lost again temporarily. Occasionally this retinal condition is confused with inflammatory effusion or choroidal atrophy; attention to the state of the fundus elsewhere, and to the pigmentary and vascular appearances, should leave no doubt as to the true nature of each of these several ophthalmoscopic changes.

Congenital irregularities in the blood-vessels of the retina are not infrequent. It is by no means uncommon to have the retina supplied in part by a branch from one of the posterior ciliary arteries, a so-called *cilio-retinal artery.* It generally pierces the disc near its edge, and then curves backwards to ramify over the adjacent retina, taking the place of a branch of the *arteria centralis.* In cases of embolism of the latter, the presence of a cilio-retinal vessel becomes important, as the portion of retina corresponding to this blood-supply retains its visual function.

Occasionally we find the retinal vessels very tortuous, simply as a congenital peculiarity. Very rarely a direct communication between a retinal artery and vein has been observed, and sometimes between a retinal and choroidal vessel.

Retinoscopy.

SYNONYMS—Shadow Test, Skiascopy, Keratoscopy, Pupiloscopy.

Retinoscopy is the most accurate and the most generally useful of the objective methods of estimating the refraction of the eye. By it can be determined the amount of hypermetropia, myopia, or astigmatism—both corneal and lenticular—that may be present, and while practising it, valuable information as to the condition of the media is obtained.

Of the two other objective methods, *direct estimation* by means of the refraction ophthalmoscope is one which should be practised whenever possible. By this method alone can differences in level in the fundus be accurately determined, while at the same time a detailed view of the fundus is obtained; but when measuring the refraction, even for the most expert, it is very difficult to get such an accurate result—especially in low degrees of astigmatism and the determination of the axes—as that obtained by retinoscopy.

The various *ophthalmometers* measure only the corneal astigmatism, and do not deal with either lenticular astigmatism or any spherical error of refraction (hypermetropia or myopia). Both these methods are valuable for estimating the refraction in certain cases.

The practice of retinoscopy is carried out as follows: The observer sits one metre in front of the patient in the dark room. The lamp is placed above and slightly behind the patient's head, so that its light falls directly on the observer and not on the patient's face. It is well that the room be as dark as possible, so that there may be no unnecessary reflections from the patient's cornea, and that the redoreflex may be of maximum brightness.

By means of a perforated mirror held up to his eye, the observer reflects the light into the patient's eye, looking meanwhile through the central aperture, when he sees at once the *red reflex.* The light from the mirror passes through the patient's pupil, and falling on the retina, illuminates a certain area. The light reflected from this area passes out from his eye to the eye of the observer, and the latter sees the patient's pupil brightly illuminated. By rotating the mirror on its axis the position of the light area is of course changed. If now the observer rotates the mirror, he will see a dark shadow—with a nearly straight edge at right angles to the direction of the movement of the mirror—pass across the patient's pupil; either in the same direction as—that is *with*—the mirror, or in the opposite direction to—that is *against*—the mirror. The edge of the shadow is the edge of the illuminated area, and the appearance of the shadow is due to the observer looking at an unilluminated portion of the retina.

It is upon the apparent movement of this light area with its attendant shadow in relation to the movement of the mirror that the method of retinoscopy depends.

The relative agreement or disagreement of the movement of the shadow and the mirror depends upon (α) the mirror that is used—plane or concave; (β) the refraction of the eye, and, in certain cases to be explained below, (γ) upon the distance of the observer from the patient.

Thus, the observer sitting at one metre from the patient with the *plane* mirror—

The shadow moves *with* the mirror in hypermetropia, emmetropia, myopia of less than 1D.

The shadow moves against the mirror in myopia of more than 1D with the *concave* mirror.

The shadow moves against the mirror in hypermetropia, emmetropia, myopia of less than 1D.

The shadow moves *with* the mirror in myopia of more than 1D.

The mirrors commonly employed are about 4 cm. in diameter. They should not have the glass perforated in the centre, since the edge of the perforation is apt to give a troublesome reflection, but merely an opening in the silvering about 3 or 4 mm. in diameter. The usual concave mirror has a focal length of 22 cm. Both the plane and concave mirrors have their special advantages, but perhaps the plane mirror is more generally useful.

To understand the relative movements of the shadow and mirror, we must trace the course which the rays of light take and find out

I. How the movements of the mirror cause the light area to move *on the patient's retina.*

(*a*) When a plane mirror is used.

(*b*) When a concave mirror is used.

II. How this light area on the patient's retina appears to the observer to move—in (*a*) emmetropia; (*b*) hypermetropia; (*c*) myopia.

I. (*a*) Plane mirror.

In Fig. 1, AA is a plane mirror, L the source of light. Rays of light reflected from the mirror AA will appear to come from a point *l*, which may be called the *immediate source of light* situated on the line L*l* drawn perpendicular to the mirror's surface, and the same distance behind the mirror that L is in front. The rays L1, L2, L3, being reflected into the eye MEH, will appear to start from *l*, and will be brought to a focus about the line *l*20, drawn from the immediate source of light through *o*, the optical centre of the eye, and strike the retina at *a*.

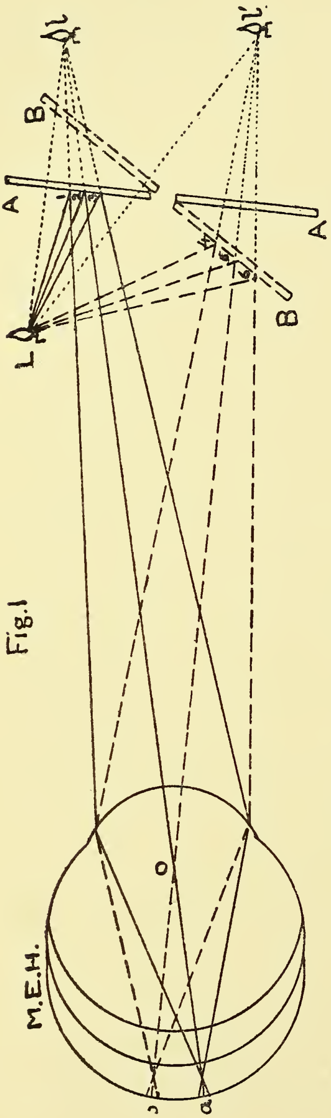


Fig. 1

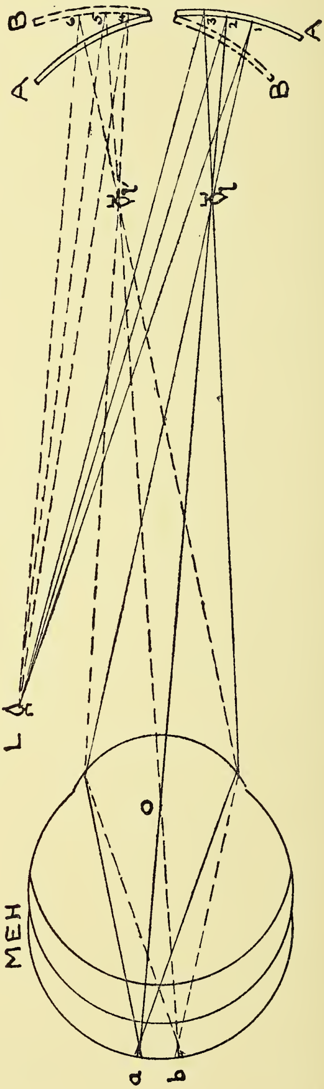


Fig. 2

If now the mirror be rotated about its axis to the position BB, the immediate source of light will then be at *l′*. The rays L4, L5, L6, which enter the eye, will be brought to a focus about the line *l′*50, and will strike the retina at *b*.

Hence it is clear that as the mirror is rotated *upwards*, though the immediate source of light moves downwards, *the light on the patient's retina moves upwards;* also it will be seen that this will be the case whatever may be the refraction of the eye.

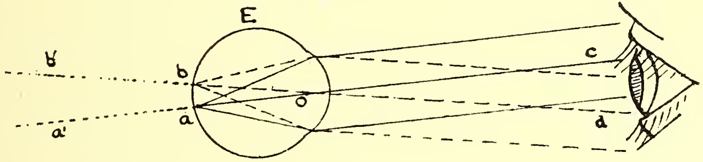
Thus the *light on the patient's retina always moves with the plane mirror in* E, M, *and* H.

(*b*) Concave mirror.

In Fig. 2, L is the source of light. AA is a concave mirror which brings the rays from L to a focus in front of the observed eye MEH. The rays L1, L2, L3, which are reflected into the eye, are made to converge, after reflection at the points 1, 2, and 3, to a focus at *l*. From *l* they will again diverge and pass into the eye. The focus *l*, then, is the *immediate source of light,* and the rays will be brought to a focus about the line *lo*—the line joining the immediate source of light and the optical centre of the eye—and strike the retina at *a*.

If the mirror be rotated upwards to the position BB, the focus of the mirror must also move upwards, and thus the immediate source of light travels from *l* to *l′*. The rays L4, L5, L6, reflected from the mirror BB, will be brought to a focus at *l′*, and passing into the eye, will be focussed about the line *l′o* and strike the retina at *b*.

Fig. 3.



Thus, while the mirror is rotated upwards, the immediate source of light moves upwards, but the light on the retina moves *downwards*—that is, against the mirror, and this irrespective of the refraction.

The light on the retina, then, always moves against the mirror in E, H, *and* M.

If by holding the mirror very close to the patient's eye, or by using a mirror of long focal length, the rays of light do not cross in front of the patient's eye, then the light on his retina will move *with the mirror,* as if a plane mirror had been used. The writer constantly uses a concave mirror of 1·5 m. focal length, and sits 1 m. from the patient. The mirror then gives the same appearances as a plane mirror, with the double advantage that, the rays being made to converge, the light is brighter, and the troublesome shadow caused by the central aperture in the mirror is almost completely abolished.

II. We have now to consider how the light on the patient's retina appears to the observer to move.

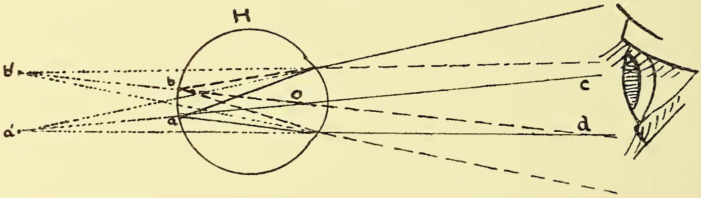
(*a*) *Emmetropia.*—In emmetropia parallel rays entering an eye are brought to a focus on the retina, therefore rays starting from the retina will emerge parallel.

In Fig. 3, E is an emmetropic eye—rays starting from an illuminated point *a* will emerge from the eye parallel to the line *aoc*; similarly, rays starting from *b* will emerge parallel to *bod*. The rays parallel to *aoc* which pass into the observer's eye will appear to him to come from a distant point, *a'*, behind the eye on the line *a'aoc*; similarly, rays parallel to *bod* will appear to come from a distant point, *b'*, on the line *b'bod*. As the light on the retina travels upwards from *a* to *b* the observer will see the light also move upwards from *a'* to *b'*. But we have seen that the light on the retina moves with the plane mirror and against the concave mirror. Hence *in* E the observer sees the light move *with the plane* and *against the concave mirror.*

(*b*) *Hypermetropia.*—In hypermetropia the retina lies in front of the focus for parallel rays, therefore rays starting from the retina will diverge as they pass from the eye.

In Fig. 4 the rays diverging from a point *a* on the retina of a hypermetropic eye, H, will appear to the observer to come from a point *a'* behind the eye on the line *a'aoc*. If the illuminated area travel from *a* to *b*, then again rays starting from *b* will appear to come from a point *b'* behind the eye on the line *b'bod*. Thus, as the light travels upwards the observer will see the light travel also upwards. Therefore *in* H, as in E, the observer sees the light move *with the plane mirror* and *against the concave mirror.*

Fig. 4.



(*c*) *Myopia.*—To understand how the observer sees the light move in a myopic eye we must take—

(i.) A myopic eye *with more than* 1*D of myopia*—in which the far point[1] lies between the patient's eye and the observer—who we suppose is sitting one metre off.

(ii.) A myopic eye with less than 1D of myopia, in which the far point lies behind the observer.

(i.) Myopia of more than 1D.

Rays starting from the illuminated point *a*, on the patient's retina, are rendered convergent on leaving the eye, and meet at the far point *a'*. From *a'* they again diverge, and entering the observer's eye, will appear to him to come from this point. Similarly, rays starting from *b* will come to a focus at *b'*, from which they will appear to the observer to come. As the illuminated area on the retina moves from *a* to *b*, the source from which the observer sees the light come moves in the opposite direction, viz. from *a'* to *b'*; that is to say, the observer sees the light move in the opposite direction to which it is moving on the patient's retina. Thus *in myopia of more than* 1D *the observer sees the light move against the plane mirror, but with the concave mirror.* (In this latter case it is seen that there is a double reversal of movement.)

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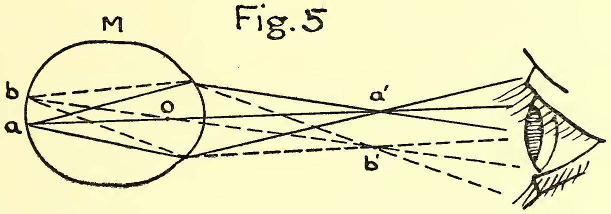
[1] The far point of an eye is the point for which the eye is focussed when accommodation is completely at rest, and therefore, conversely, rays starting from the retina are brought to a focus at the far point.

The F.P. of an eye having 1D of myopia lies 1 metre off.
,, ,, ,, 2D ,, ,, 0·5 ,, ,, .
,, ,, ,, 0·5D ,, ,, 2 ,, ,,

that is to say, the distance of the far point varies inversely with the degree of the myopia.

(ii.) Myopia of less than 1D. If the far point be situated behind the observer's eye the rays will not have crossed before entering his eye, and there will be no apparent reversal in the movement of the light. Therefore in this case the observer will see the light move in the same direction as it is moving on the patient's retina. Thus in *myopia of less than* 1D the light is seen to move *with the plane mirror* and *against the concave mirror*, as in H and E.

Fig. 5

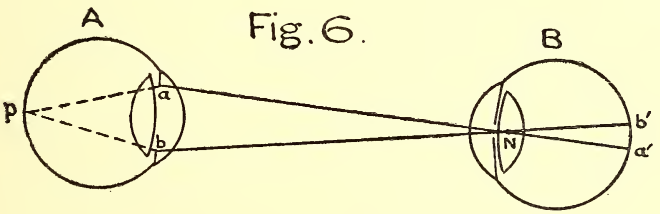


From the above considerations it is clear that between (i.) and (ii.) there must be a position of the far point at which, though the mirror is moved, the light and shadow do not appear to move at all; that is to say, the pupil appears either bright or dark, and no shadow is seen to move across it. What is this position? It is when the far point is situated at the observer's eye, or more accurately, when the rays from the illuminated retina are focussed exactly at his nodal point. This is termed the *point of reversal.*

This may be simply explained as follows:—Let A be the observed eye and B the observer's eye. The image of the pupil *ab* will be found on the observer's retina at *a'b'*.

If the far point of the eye A lie at N, the nodal point of the eye B, rays from the very small area *p* (the size of which depends upon the size of the observer's pupil) will cover the whole area *a'b'*, and the observer therefore sees the whole of the patient's pupil illuminated. Thus, if *p* be illuminated the whole pupil will appear bright, if it be not illuminated the whole pupil will appear dark—hence at the point of reversal the whole pupil flashes either bright or dark—a condition of partial illumination of the area *a'b'* is impossible, and no shadow is seen to move across the pupil.

Fig. 6.



If then the observer's eye be 1 metre from the observed eye, and movement of the mirror causes no moving shadow, we know that the eye must have a myopia of 1D.

We are now in a position to understand the rule for estimating the refraction of an eye, viz. to place in front of the observed eye convex lenses in hypermetropia, and concave lenses in myopia of gradually increasing strength, until the shadow ceases to move, when we know that the corrected eye has become myopic to the extent of 1D. We must deduct, therefore, 1D from the lens which abolishes the movement of the shadow to give the true correction of the error of refraction.

Thus, suppose it takes sph. +4D to correct a hypermetropic shadow, that is to say, sph. +4D gives the corrected eye 1D of myopia, the refraction of the eye is +3D of hypermetropia; again, suppose it takes sph. −5D to correct a myopic shadow, that is to say, sph. −5D leaves the corrected eye with 1D of myopia, the refraction of the eye is −6D of myopia.

It will be obvious from what has been said that the position of the observer is of great importance. We have seen that with the observer at 1 metre (the position of the far point of an eye of 1D of myopia), the glass which corrects the shadow leaves a myopia of 1D, but if the observer sits at 4 metres (the position of the far point of an eye of 0·25 of myopia), the lens which corrects the shadow will leave only 0·25D of myopia; similarly, when the observer sits at half a metre, the glass which corrects the shadow will leave 2D of myopia. The position of 1 metre is chosen for convenience, since glasses can easily be changed without the observer rising from his chair. The nearer the position chosen by the observer the greater is the error caused by unintentional variation from this position. Sometimes it is difficult to be certain which lens absolutely does away with the movement of the shadow; this may be tested by leaning forward a little, when the shadow should become "myopic," and again by moving back, when the shadow should become hypermetropic.

In order to appreciate the movement of the light area it is by no means necessary that the rays from this area be focussed on the observer's retina; indeed there is a considerable range in the position of the far point, both in front of and behind the observer's nodal point, in which it is quite impossible for a sharp image of the light area to be formed on the observer's retina, yet the movement of the light is always easily seen except at one point—the point of reversal.

Since the point of reversal depends upon the coincidence of the far point of the observed eye and the observer's nodal point, it is clear that, *provided the distance of his nodal point remain constant,* the same glass will be found to correct the movement of the light and shadow whether the observer be E, H, or M, and if ametropic, whether he wear his correction or not, or again whether he uses or relaxes his accommodation.

The brightness of the light area on the patient's retina, and the sharpness of the shadow, will depend chiefly upon the accuracy with which the light is focussed on the retina. When, therefore, the immediate source of light corresponds with the far point of the eye, the light area will be at its brightest, and the shadow most distinct.

The brightness of the light area and the sharpness of the shadow, *as it appears to the observer,* will depend upon the actual brightness of the light area, and also upon the degree of magnification. The magnification of the retina varies with the distance from which it is viewed. The farther the observer's eye from the point of reversal, the less the magnification; the nearer the point of reversal, the greater the magnification, until at the point of reversal the magnification is at the maximum.

This can easily be shown by looking at an object through a convex lens; when the lens is held close to the object the magnification is low; increase the distance and the magnification is raised, till at last one point only of the object is seen highly magnified. By removing the lens still farther a magnified reversed image is seen, which becomes smaller as the distance is still more increased.

On the degree of magnification depends also (*a*) *the rate of movement* of the light area and shadow (the rate of movement of the mirror remaining constant), and (*b*) the shape of the shadow.

With low magnification the shadow appears to move *slowly,* and a larger portion of the edge of the light area being seen, the shadow appears *curved.*

With high magnification the shadow seems to move *faster,* and as only a small portion of the edge of the light area is seen, much increased in size, the shadow appears *straight.*

Hence in high degrees of uncorrected H and M, where the magnification is low the light area appears dull, the shadow is curved and moves slowly.

As the point of reversal is approached the magnification increases, and the light area appears brighter, the shadow moves faster and has a straight edge.

Regular Astigmatism.—In regular astigmatism the refractive power of two meridians at right angles to one another is different. There must be, therefore, two far points, one for each meridian. In measuring the astigmatism by retinoscopy, the refraction of each meridian must be estimated separately, and the difference between the two correcting lenses will be the measure of the astigmatism.

Thus, suppose the vertical meridian be corrected by a lens of sph. + 4D, and the horizontal meridian by a lens of sph. + 6D, with the observer sitting at 1 metre from the patient; then sph. + 4D combined with cyl. + 2D axis vertical will give the patient 1D of myopia; the true correction, therefore, of his refraction will be sph. + 3D cyl. + 2D axis vertical.

Again, suppose the vertical meridian be corrected by sph. + 1·5D, and the horizontal by sph. – 0·5D, then either sph. + 0·5D cyl. – 2D axis vertical or sph. – 1·5D cyl. + 2D axis horizontal will give the true correction. *N.B.*—The cylinder must be placed with its axis at right angles to the meridian which it is to correct; it does not affect the meridian corresponding with its axis.

When the point of reversal for one of the meridians is nearly reached, it will be noticed that the light area has a *band-like* appearance, and that the direction of the band remains constant whatever the movement of the mirror may be. The axis of the band indicates the axis of that meridian; which observation is of great practical use when ordering glasses for children, with whom the suggestive test is unreliable. The reason for this band-like appearance is that the light area is magnified to the maximum by the meridian at whose point of reversal the observer's eye is, and therefore to a much greater degree than by the opposite meridian. The light area is thus drawn out, as it were, and appears as a narrow band of light with a straight shadow on either side.

Double Shadows.—It is commonly found that a given lens will correct the shadow in the periphery, while there still remains an uncorrected shadow in the centre of the pupil, or *vice versa.* That is to say, the centre of the pupil appears as it were more hypermetropic or more myopic than the periphery. Of the two conditions the former is more common, and is due to the spherical aberration of the refractive media. In common with all spherical lenses, the periphery is more refractive than the central part, hence the centre may appear hypermetropic, while a myopic shadow is seen in the periphery. In these cases *always correct for the movement of the* *brightest part of the central light area,*[1] since it is through the centre of the pupil that the patient looks.

In conical cornea, lenticonous, and other allied conditions, the central shadow appears myopic, while the periphery appears hypermetropic; here again, as a rule, the movement of the central light area is the one to be corrected.

In *irregular astigmatism* a variety of conflicting shadows is often found; and though in some cases retinoscopy may lead to a right estimation, in others the subjective method of trial with lenses must be resorted to.

Mydriatics.—In order to obtain the most accurate estimation of the refraction by retinoscopy, the accommodation of the patient must be completely at rest, and he should look at the hole in the mirror in order that the light may play over the macular region. This is the part of the retina for which the correction is needed, and the refraction of the macula may be different from that at other parts of the fundus. Atropia undoubtedly gives the most complete relaxation of the accommodation, but the effects last for about ten days, and in elderly people the danger of inducing glaucoma must never be forgotten.

For children with active accommodation, and to whom time is as a rule of no object, a 1 per cent solution of atropin may be used three times a day for three days previous to examination. If atropin be contraindicated, homatropin and cocain may be used in—(i.) Discs containing gr. $\frac{1}{50}$ of each; or (ii.) A 2 per cent solution of each in castor oil (*N.B.*—One application only should be made, and only a very small quantity should be applied, and this should be spread over the cornea by means of the upper lid; an ordinary-sized drop causes a disturbing film over the cornea); (iii.) Many prefer a 2 per cent watery solution instilled four times at intervals of ten minutes. (Occasionally the cocain causes a roughening of the corneal epithelium. To avoid this it has been recommended to use the H. and C. solution the first and fourth time, and a 2 per cent solution of homatropin alone for the second and third installation.)

In whichever form the H. and C. be applied, the full effect is gained in about forty minutes. The effect passes off in about twenty-four hours, but if after examination a drop of a 1 per cent solution of eserin be instilled the mydriasis passes off in less than an hour. In elderly people with very small pupils, whose accommodative power is slight, sufficient dilatation of the pupil may be gained safely with a 2 per cent solution of cocain, or one application of H. and C., followed by a drop of 1 per cent solution of eserin.

It is well before ordering glasses to test the patient again with the trial lenses, after the effect of the mydriatic has passed off, *except in the case of children.*

Some deduction has, as a rule, to be made from the spherical lens (not the cylinder), which gives the full correction under the mydriatic. In children 1D may be deducted from the full atropin correction, except in the case of convergent strabismus, when only 0·5D should be deducted. Adults vary considerably; some will accept their full correction, others require even 1D to be deducted. Where it is impossible to test a second time, it is usually safe to deduct 0·75D or 1D atropin, as in children, and 0·5 for homatropin and cocain. (For special correction of myopia, see article on "MYOPIA.")

RETINOSCOPY WITHOUT A MYDRIATIC.—In adults mydriatics may be undesirable from one reason or another, and in many cases retinoscopy without their use, combined with a careful subjective test, will give excellent results. Certain points, however, need specially to be considered. If a patient, not under the influence of a mydriatic, look straight at the sight hole of the mirror two difficulties at once arise: firstly, he will use his accommodation; and, secondly, his pupil will become so small that the movement of the shadow can hardly be distinguished. The patient should therefore relax his accommodation by looking to the other end of the dark room past the observer's *right* ear, when his *right* eye is being examined, and past the observer's *left* ear when the *left* eye is under examination; the observer meanwhile must use his right eye when examining the patient's right eye, and his left for the patient's left eye. In this position the light is thrown by the mirror on the optic disc—the least sensitive part of the fundus—and the pupil therefore does not contract so much, and at the same time the reflex is brighter. The error introduced is that the refraction at the disc may not be the same as at the macula, but with careful subjective testing this error may as a rule be eliminated. If, however, any difficulty be experienced a mydriatic should be used.

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[1] Throughout this article the movement of the light area with its attendant has been described for the sake of clearness as the object for observation. The writer would strongly urge the advisability of watching the movement of the brightest part of the illuminated area, seen about the centre of the pupil; as the shadow is at times very indefinite, while the movement of the light area may be quite distinct, and this is especially seen in the above-mentioned cases with double shadows.

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Retro-Pharyngeal Abscess. *See* PHARYNX.

Rheumatism.—This subject is discussed under the following sections:—

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Acute Rheumatism

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RHEUMATIC fever is a disease extremely difficult to define, and yet, when it occurs in its usual types, has all the characters of a specific affection. It is when the unusual forms of the disease are studied that we are led to recognise that it is one of a large group of diseases, each member of which possesses definite characters, but all of which bear a certain family resemblance to one another. The malady is a very serious one, and in the crowded cities of England very common; but because it is not often directly fatal, the serious results that arise are liable to be imperfectly realised. Again and again we see, especially among the hard-working classes, the young, the attractive, and intelligent, maimed by serious heart disease, and can trace from a first attack of rheumatic fever the commencement of a life of suffering brightened only by brief intervals of respite.

Ætiology.—The causes may be divided into the predisposing and exciting.

Predisposing Causes.—Inheritance is of much importance, and double inheritance is more liable to result in a severe attack in the child than is heredity on one side only.

It is probable that there is in rare instances direct infection of the fœtus through the placental circulation, and there is little doubt that some cases of congenital heart disease are due to this direct infection, though more usually there would appear to be not a direct infection, but an inherited vulnerability of the tissues.

Rheumatic fever is more common in childhood and adolescence than in adult life; and not only this, the disease is more virulent and the manifestations more numerous in the young. One attack does not confer immunity, and there appears to be in many instances an increased liability to further attacks. On the other hand, with advance in age the resisting power of the constitution increases, and in considering immunity, we must remember that it is extremely difficult to feel sure when an attack of rheumatic fever is absolutely cured.

The influence of sex is inconsiderable. The season of the year has a marked effect: in autumn and spring rheumatic fever is rife, and if the autumn commences with cold and wet, after a long spell of dry and hot weather, numerous cases are sure to be met with in the towns. As Dr. Newsholme has insisted, rheumatic fever is an urban disease, and he associates it also with a low level of ground water.

Mental and physical strain are additional factors. There is good reason to believe that the strain of education, examinations, and the contest for medals among the underfed and more intelligent of the children of the poor, assist in the causation of the choreic type of rheumatic fever.

Sudden chill, especially if with this there is physical overstrain, is a powerful predisposing cause, and it is not uncommon to get a very definite history of such an occurrence from which the attack can be accurately dated. Acute rheumatism appears to be ubiquitous, but in warm and equable climates its occurrence is not so frequent, and it is not unlikely that the thorough realisation of rheumatic fever as an infective disease will bring to light some important facts upon this question of climatic influence.

Epidemics have been recorded by Dr. Mantle and others, but they are unusual.

That any particular diet predisposes does not seem probable, and rests on no very sure evidence. Insufficient food, the emanations of sewer gas, and overcrowding, by lowering the health are predisposing causes, and of these foul air is probably an important one.

The Exciting Cause.—Rheumatic fever is an infective disease, and as in other diseases of this type there are many factors which predispose to the actual infection, so, too, the same is true in rheumatic fever. The question also arises whether, in addition to various predisposing factors, there are several exciting causes. The answer to this question cannot yet be said to be decided, though, as the result of my researches with Dr. Alexander Paine, I believe that one and not several different bacteria will prove to be the true excitant of rheumatic fever. This in any case may be asserted with confidence, that the excitant is a bacterial infection; and that the view of the infective origin of the disease has not been the result of a sudden desire to keep, as it were, in the fashion, but has been the outcome of many years of investigation by clinicians, pathologists, and bacteriologists, and that by this view the manifestations are well explained.

At first the results of bacteriological investigation were indecisive, but of late Triboulet and Coyon, Wassermann, Poynton and Paine, and Fitz-Meyer have independently isolated diplococci which, though differing in some minor respects, appear to be identical and to be a cause of the disease. The earlier researches of Wilson, Mantle, von Leyden, Löffler, and many others, prepared the way for these later investigations. The micrococcus, as described by Dr. Paine and myself, is minute, and essentially a diplococcus, each element of which is ·5 μ in diameter. On solid media it grows in staphylococcal masses, in liquid media in streptococcal chains, each element of which is a diplococcus. We found the most favourable culture medium was blood-agar, or milk and bouillon slightly acidified with lactic acid. We have isolated it from twenty cases of rheumatic fever. It is present in the local lesions, and in the blood and urine of the living patient suffering from pericarditis. Injected intravenously into rabbits it reproduces the disease, and can be isolated from the local lesions. The organism is rapidly destroyed at the sites of the local lesions in man, and this fact, together with its minute size, makes it difficult to find in the tissues. We have succeeded in demonstrating the diplococcus in the nodules and in the synovial membranes of the joints, and have isolated it from both these structures and from most of the rheumatic lesions. It is usually present in the exudations, though in very acute and clear effusions it may be absent, or present only in small numbers.

In suitable media it lives for long periods, and keeps in some measure its virulence. It stains well with the aniline dyes, but in the tissues does not retain the gentian violet used in Gram's method with tenacity.

The diplococcus certainly gains access to the system through the tonsils, and may also do so by other paths which have not as yet been demonstrated.

On the other hand, Singer maintains that rheumatic fever is an attenuated pyæmia due to infection with various pus-forming cocci. But it appears inadvisable to consider such a constant disease as rheumatic fever as an attenuated pyæmia, until several specifically different pus-forming micrococci are proved conclusively to cause rheumatic fever.

A brief allusion must also be made to a view which maintains that arthritic rheumatism is the true disease due to an unknown excitant, and that pericarditis and the other severe lesions are the result of secondary infections. To consider rheumatic fever as a multiple arthritis or the severe lesions as complications, is, in our opinion, contrary to clinical experience, for they are manifestations of the disease in its severe forms; further, the diplococcus may be present in the synovial membranes of the joints although the clear exudation may be sterile, and hence these lesions which are looked upon by upholders of the view as true rheumatism, are identical in their origin with other rheumatic manifestations.

Although there are such strong reasons for believing the cause of rheumatic fever to be an infection with a diplococcus, this can only explain one factor in the disease—the exciting cause. The peculiar poisons that are formed, and the peculiar vital chemistry of the human tissues, are as yet unknown.

The Morbid Anatomy.—In studying the morbid anatomy of rheumatic fever we are struck by the numerous local lesions that are found, and the disease in this respect is in marked contrast to diphtheria, in which the local lesions are but few. In these positions the diplococci are rapidly destroyed by the cells of the living tissues, but while present in these lesions they give rise to a condition of inflammation which often leaves the tissues more or less damaged. These various inflammations in rheumatic fever rarely suppurate, but when the tissue changes are severe the process of recovery is incomplete, and sclerosis and consequent deformity of such delicate structures as the cardiac valves will result.

The recovery from arthritis is usually complete, and nodules may entirely disappear, but inflammation of the valves and pericardium repeatedly ends in deformity of the valve segments and adhesion of the pericardium. So also in some cases the joints do not completely recover, and the nodules may persist for many months. We are prepared—since the local changes are the result of the invasion of the diplococcus—to find that the various lesions of rheumatism are all of the same type, when due allowance has been made for the anatomical peculiarities of the various tissues.

If, for example, rheumatic valvulitis is chosen to illustrate those changes, they will be found to be the following :—*Microscopic.*—When the diplococcus gains access to the valve, the connective tissue immediately beneath the endocardium swells, and the fibres become indistinct and separated by a slight exudation. Thus the endocardium at that point is raised above the general surface of the valve. Later the connective tissue cells proliferate, the endothelial lining is destroyed, the destructive process advances to the stage of necrosis, and numerous leucocytes will be found in the damaged tissues. Thus the vegetation is formed, and usually there are a series of these fringing the edge of the segments of the valve. To these vegetations fibrin often becomes attached, but this deposit of fibrin is no essential factor in their formation. Repair commences by invasion of the necrotic part of the granulation by fibroblasts, and thus eventually sclerosis and deformity of the valve result. It is an important fact that by the time the vegetation is completely formed most of the organisms are destroyed by the activity of the tissue cells and leucocytes.

The macroscopic appearances of rheumatic valvulitis vary with the stages of the process. In the acute stage, if the valve was previously uninjured, minute reddish pink elevations are visible, and the valve itself is swollen. When the process is less acute and the valve damaged by earlier attacks, minute yellow, somewhat translucent excrescences are formed. After repeated attacks of inflammation the sclerosis of the segments of the valve which results is only too well recognised. The mitral valve is the most frequently, and also the most extensively injured. Next in order comes the aortic valve, then the tricuspid, which in childhood is affected more often than is generally thought, and, finally, though rarely, even the pulmonary valve may show slight beading.

The nodule passes through a like series of changes ; under the microscope in an early nodule the zones of necrosis, cell proliferation, and swollen connective tissue can be readily traced, and in the interstices of the swollen connective tissue the diplococci may be demonstrated. In their macroscopic appearance these nodules resemble a minute sago grain, but the more carefully an attempt is made to dissect them from the tissues, the more surely do they disappear under the knife, for the exudation within them is pressed out, and scarcely a trace of the nodule can then be seen. They are not therefore in their characteristic stage *fibrous* nodules.

When the diplococci attack the more vascular structures, such as the pericardium or joint capsules, they locate themselves in the delicate areolar tissue immediately beneath the endothelial lining. Great dilatation and often rupture of the capillary blood-vessels result, and there is the same cell proliferation, leucocytic invasion, and connective tissue swelling as already described. The exudations into the pericardial sac or joint cavities are at first clear or blood-stained, and when the endothelium is intact are usually sterile. This latter fact is also confirmed by experiment, which is important, for investigators have experienced difficulty in isolating the organism from these clear effusions.

Later the fluid becomes more opaque and fibrino-cellular, and in some cases layers of the plastic exudation are deposited upon the inner surface of the pericardium and synovial membrane. A film of these later exudations will show under the microscope numerous leucocytes, which for the most part stain well with aniline dyes and are not necrotic. The interstitial tissue between the muscle bundles in the neighbourhood of the inflamed joints is also the seat of similar changes. The tendon sheaths may suffer in exactly the same way, and the morbid changes in the pleura are also of the same character.

The macroscopic appearances of the pericardium, pleura, and joint capsules are much alike, although, since it is the virulent rheumatism in which the pericardial tissues are especially attacked, the changes in that structure are usually more definite. In the early stage there is swelling, the tissues on section look gelatinous, and where the blood-vessels are chiefly distributed there is much hyperæmia. Later there may be sclerosis and adhesion.

The rheumatic poisons are injurious to the myocardium. In severe cases there is considerable fatty degeneration of the fibres, and though this change is most evident beneath the inflamed pericardium, it occurs throughout the heart wall, and is especially noticeable in the neighbourhood of the blood capillaries. In some cases there may also be considerable cell exudation in the fibrous tissue between the muscle bundles, and when the process is long continued a definite fibrosis of the heart wall results.

Acute arteritis has been described by Legroux as a result of rheumatic fever. The changes commence immediately beneath the lining of the vessel wall, and are of the usual type.

Another morbid change in connection with the cardio-vascular system is a fibrosis around the small arterioles and capillaries, and is of interest as seeming to throw some light upon the pathology of arterio-capillary fibrosis.

Phlebitis with consequent thrombosis may also result from the rheumatic process. There is absence of suppuration, and in severe cases after the process has subsided the clot is organised and the vessel converted into a fibrous cord.

The study of the morbid anatomy of such viscera as the lungs, the liver, the spleen, and the kidneys, is a more difficult matter. There are the complicating factors of cardiac failure from mechanical embarrassment due to injury of the valves and consequent "backworking." There is also the fortunate rarity of death from a first attack. We are cramped, too, by such familiar terms as "nutmegged liver," "mechanical congestion of the lungs," and "cyanotic induration of the kidneys." Yet there are good reasons to believe that, apart from the well-recognised and definite changes due to cardiac failure, there is also another series of changes in these viscera, the direct result of the rheumatic infection.

The Lungs.—Pneumonia, for example, is one of this series.

Rheumatic pneumonia is broncho-pneumonic in its distribution and seldom massive, as is the pneumonia due to the diplococcus lanceolatus. The patches are generally near the pleural surface of the lung, though in some cases they are scattered throughout. There is some amount of pulmonary collapse around these areas of pneumonic change. The blood-vessels are greatly distended, and there are often hæmorrhages in the alveoli, which also contain endothelial cells and leucocytes, but, as a rule, not a well-marked network of fibrin.

The diplococci, which are very small and not lanceolate, are sometimes present in great numbers in the exudation.

Apart from mechanical congestion of the lungs, a definite pulmonary œdema sometimes occurs which is most marked in the upper lobes. The lung is firm, but doughy on pressure, and on section much œdema fluid can be squeezed from the cut surface. Microscopic examination shows that the alveoli are full of this œdema fluid.

The Liver.—In a fatal first attack of rheumatic fever, when there is no œdema or other definite evidence of "backworking," the liver will be found uniformly pale, and a section of such a liver shows extensive fatty changes, which have not the distribution characteristic of the "nutmeg liver." The change is general, and most probably the direct effect of the rheumatic poison. The occurrence of hæmatoporphyrinuria has, from quite another line of evidence, been pointed out by Dr. A. E. Garrod as extremely suggestive of alteration in the hepatic metabolism in rheumatic fever.

The Spleen.—In some of the more malignant types the spleen, as pointed out by Professor Litten, is uniformly enlarged, without a trace of infarction to account for it. But, as a rule, the spleen does not seem to be one of the viscera which is much altered by the direct effect of rheumatic fever.

The Kidneys.—In severe cases there may be well-marked cloudy swelling, coagulation necrosis, and fatty change in the cells of the convoluted tubules of the kidneys, and it is very probable that the toxins are excreted by this channel and are the cause of these changes. Hæmaturia, apart from infarction, may result in the malignant types of the disease, and albuminuria may also occur, both of which occurrences lend support to the view that the rheumatic poisons have a direct action upon the kidneys, though in man this is not usually of a severe type. The diplococcus can be isolated from the urine in virulent cases of rheumatic fever.

The Brain.—The morbid changes in rheumatic chorea are extremely difficult to ascertain, the opportunities are so rare, and the brain so difficult to thoroughly investigate. Hyperæmia and minute hæmorrhages, exudation around the capillary blood-vessels, cloudy swelling of the neurones, sometimes minute emboli or thromboses, and a slight leptomeningitis, are among the changes observed, and are such as we should be led to expect.

After death from hyperpyrexia, as a rule, no definite morbid changes have been found in the brain.

Angina Faucium.—The faucial inflammation is in no way distinctive; it is usually catarrhal and rarely suppurative, but there may be a membranous deposit upon the tonsils or a condition of follicular tonsillitis. From repeated attacks considerable fibrosis of the tonsils results, and a section through such tonsils may show loculi containing inflammatory exudation at some distance from the surface.

The diplococcus gains access to the system through the tonsils, and may be found in the interstitial framework in the neighbourhood of the small blood-vessels; but to isolate them from the numerous micro-organisms that are always present in the throat is a very difficult undertaking in the present state of our knowledge.

The Cutaneous Lesions.—Apart from the sudamina and miliaria, there is in most of the rheumatic lesions great dilatation of the blood capillaries, and often, as in purpura, actual rupture of their walls. In addition, in some cases there is considerable exudation into the subcutaneous tissues, a change which is especially noticeable in erythema nodosum.

Infarction.—The occurrence of infarcts in the viscera in rheumatic fever is an interesting problem. They occur far more frequently in malignant endocarditis, and are ascribed to the detachment of portions of the exuberant vegetations or to detached blood-clot. In simple rheumatism they occur most usually in advanced mitral lesions.

The Blood.—There is usually well-marked coagulation of the blood after death.

SYMPTOMS AND COURSE.—Rheumatic fever has no definite incubation period, and the onset may be either acute or, as is more usually the case, gradual. When the onset is acute there is some definite history of chill or exposure from which the illness is dated, and the first symptoms generally show themselves within a week.

There is a feeling of malaise, with moderate fever and chilliness; there may be a sore throat or stiff neck, and the eyes look dull and heavy. Muscular feebleness, fleeting pains in the limbs, and prostration follow, and usually in the adult acute multiple arthritis develops and makes the diagnosis clear. When the onset is gradual there are often vague symptoms, which, now the disease is recognised as infective, are of much interest. Anæmia, irritability, loss of energy, and wasting are frequent, especially in young subjects. Again, headache, epigastric pain, and stiffness in the muscles and joints, are very suspicious symptoms, the more so if they are accompanied with a slight rise of temperature.

The acute attacks of rheumatic fever in adult life we associate with a rapid and transient multiple arthritis, which quickly renders the patient quite helpless, and at the same time makes the nature of the illness apparent. Yet it is unfortunately the case, that with them as with children, the first unequivocal sign of rheumatic fever may be inflammation of the heart and not arthritis, and this carditis may have been in existence for some days before precordial pain and breathlessness convince the patient that he is seriously ill.

A severe attack of the arthritic type of rheumatic fever is at its height a very characteristic disease. The sufferer lies in bed quite helpless, dreading the slightest movement; many of the larger joints, and not infrequently the smaller ones as well, are swollen and extremely tender. Over the joints, which feel hot to the touch, there may be a red flush, and the implication of the tendons and the periarticular tissues in this transitory inflammation add to the distress.

From day to day joints which were previously unaffected are attacked, and others already inflamed begin to subside often with great rapidity.

The temperature is raised to a moderate degree (102°), but runs no definite course. The mind is clear and as a rule acute; the tongue is thickly coated with a white fur. In many cases there is profuse sweating, and the sour odour that is present has long been pointed out as a feature of the illness. If the sweating is profuse there is considerable thirst, but the appetite is lost, and bowels are often constipated. The pulse varies with the extent of the implication of the heart, but it is usually increased in rate, regular, with a large wave, and easily compressible. Examination of the heart very frequently shows that there is a definite dilatation. The impulse is diffuse; the area of deep cardiac dulness increased, especially toward the left; the first sound of the heart over the region of the impulse is short, and the second sound over the pulmonary area accentuated. In addition there may be a soft systolic murmur heard most plainly internal to and slightly above the left nipple.

This represents the earliest affection of the heart in rheumatic fever, and this eminently recoverable condition may drift almost imperceptibly into organic valvular disease. The clinical importance, therefore, of this dilatation is, as Dr. D. B. Lees has insisted, great.

The *respiratory system* is but little affected. Except for anxiety and distress of mind, with insomnia from the pain, there are no definite *nervous* disturbances. *The urine* is scanty, high-coloured, and strongly acid; the chlorides are diminished, and the urates are increased and form a thick deposit. Hæmatoporphyrin is sometimes present in large quantities.

The course of the illness is very indefinite, and may be protracted by repeated relapses over many weeks. An acute attack lasts, as a rule, about three weeks, but at the present time active treatment is so commonly adopted that it hardly serves a useful purpose to lay down any definite duration for the illness. Rheumatic fever is one of those diseases from which convalescence is often slow, and in which it is extremely difficult to feel sure when all active symptoms are at an end. Recovery finds the patient anæmic and prostrate, and it is not uncommon to find that the joints remain stiff and muscles tender for a long time after the recovery is otherwise complete. On the other hand, an acute attack of the arthritic type is very rarely indeed fatal, and when this is the case death is usually due to the supervention of cerebral rheumatism and hyperpyrexia.

In thus sketching briefly the clinical symptoms of the arthritic type of the disease, I do not wish to imply that the more severe types of rheumatic fever with visceral inflammations are complications of the true disease. To this extent they are complications, that they introduce many new dangers, and need a more elaborate watchfulness and care in their treatment, but they are, I believe, essentially rheumatic manifestations and not the result of secondary infection.

To enter into detail upon these various manifestations would be to trespass upon the articles already devoted to their study, and it must suffice to point out the chief clinical symptoms which lead the physician to recognise their occurrence.

First in order of importance are the cardiac affections—endocarditis, pericarditis, and myocarditis. The proper understanding of these will be much simplified if it is recognised that in severe rheumatism of the heart all the structures are injured, and that the condition is one of carditis—but in some cases the brunt of the disease falls on the valves, in others on the pericardium, and again in others, probably, on the myocardium. Recalling the teaching of the morbid anatomy, we must dismiss from our minds the idea that myocardial changes necessarily spread from the pericardial inflammation, and recognise that they are a morbid result of the rheumatic poisons upon the muscular structure, as much as are the somewhat similar though more intense changes in diphtheria the result of the toxins of that disease.

As age advances the cardiac affections become less frequent, but dilatation of the heart, the earliest evidences of which have already been described, still remains frequent.

Endocarditis.—It is difficult to determine at the bedside when the valves are actually inflamed, for the onset of the valvulitis may be at any period in the disease, and the amount of general disturbance very slight. Reduplication of the second sound over the impulse, especially if with this there is a soft systolic murmur which can be traced toward the left axilla, points strongly to some damage of the segments of the mitral valve, and though the murmur may subsequently disappear, this persistent alteration in the character of the second sound betrays that the valve has been slightly damaged.

Any rise of temperature or increase in the rapidity of the pulse must be looked for as an additional proof of the occurrence of endocarditis.

Malignant endocarditis is fortunately not a common occurrence in rheumatic fever, though, from investigations made with Dr. Alexander Paine, I am convinced that this result may be a manifestation of rheumatic fever, especially when the valves have been damaged by previous attacks of rheumatism. The onset of this fatal form of valvulitis is usually very gradual; persistent rapidity of the action of the heart, loud and often musical murmurs, irregular fever, infarction, anæmia, and emaciation are among the important indications. In some cases there is doubt as to the diagnosis, even to the very end of the illness, but, as a rule, with the progress of the disease the symptoms diverge more and more from those which are associated with simple rheumatic fever.

Pericarditis.—It is the virulent rheumatic infections, such as are more frequently seen in childhood, that give rise to pericarditis, and its occurrence is always a grave matter. But to separate rheumatic pericarditis from endocarditis and myocarditis, and to study it apart from them, is difficult and in some degree misleading. There are many cases of carditis in which pericardial inflammation cannot be detected or does not occur, which nevertheless damage the heart very seriously, and their importance is apt to be under-rated because pericardial friction has not been heard. Overmuch of the actual damage to the heart in rheumatism has very probably been laid at the door of pericarditis and the adherent pericardium, which is so frequent as a sequel.

Pain over the heart, dyspnœa, a rise in the temperature, pallor of the face, mental anxiety, and even delirium, are among the early signs of pericarditis. The pulse is rapid, often irregular, and the tension remarkably low. The pericardial friction sound is frequent, and it may not be out of place here to insist upon the fact that the greatly increased area of the cardiac dulness that is so common is far more often the result of cardiac dilatation than of a large pericardial effusion.

Myocarditis.—The myocardial changes in rheumatic fever are very difficult if not impossible to diagnose, though we may often have good reason for suspecting them. Insidious myocardial disease of rheumatic origin is also very possibly more important than is generally recognised, for it is undoubted that there are cases of rheumatic morbus cordis, the symptoms of which are far more urgent than the physical signs would lead us to expect, and which are some of them due to damage to the cardiac muscle.

All rheumatic affections of the heart may commence so unobtrusively that nothing but a routine and careful examination in every case of rheumatic fever can protect us from error. And when rheumatic fever has left its traces on the heart, and the patient is numbered as one of the great group of cases of morbus cordis, it is more often a fresh attack of rheumatism that injures the compensation of this damaged heart than any direct mechanical overstrain.

Phlebitis and Venous Thrombosis.—Phlebitis and venous thrombosis are among the more unusual occurrences, though within the last four years I have met with six undoubted examples, which leads one to suppose it may be more common than is perhaps thought to be the case. French observers have frequently observed the condition, and state that phlebitis is most common in the lower extremities. The phlebitis in my experience has commenced in the large veins of the arms and neck, and all tributaries of the superior vena cava, including the upper part of the vein itself, may be occluded.

The diagnosis rests upon the occurrence of localised œdema of the arms, face, or chest, with tenderness along the damaged veins, dilatation of the collateral vessels, and sometimes the discovery of firm cords in the position of the veins. In four of the six cases that I have seen there was also pericarditis.

CHANGES IN THE BLOOD.—*Anæmia.*—During an attack of rheumatic fever there is a fall in the number of red blood corpuscles. The decrease is usually rapid, and in convalescence this loss may also be rapidly repaired. There are cases, however, in which, as Dr. A. E. Garrod has pointed out, anæmia may persist for a long while, and in which there is a fall in the hæmoglobin worth of the blood corpuscles. There is very often a moderate leucocytosis, and this in exceptional cases may be very marked, and the leucocytes contain diplococci. In severe cases of pericarditis the diplococci circulate in the general blood-stream, and can be isolated from the blood, but in the less severe cases it is doubtful if even with 10 c.c. of blood any constant results would be obtained.

RESPIRATORY AFFECTIONS.—*Pleurisy.*—Rheumatic pleurisy is frequent where there is pericarditis, and those parts of the pleuræ which overlap the pericardium are especially liable to be attacked. Pleuro-pericardial friction is perhaps more frequent in rheumatic fever than in any disease, for as a rule this inflammation is plastic. Pain in the side, a catch in the breath, and a pleural friction rub, are usually present in rheumatic as in other forms of pleurisy. Rheumatic pleurisy may no doubt also occur apart from pericarditis, and it is an important question that yet remains to be solved, how many primary pleurisies, which are non-suppurative, are rheumatic and not tubercular in their origin.

Pneumonia.—Rheumatic pneumonia is frequent in the severe attacks of visceral rheumatism. The clinical features are in some respects remarkable. It is, as stated in the study of the morbid anatomy, essentially a bronchopneumonia, and when due allowance is made for the collapse of the left lung, which always occurs when the heart is much enlarged, it is doubtful whether, as has been maintained, it occurs more frequently on the left side. It may certainly be present on both sides. The physical signs are sometimes much more extensive than the lesions would lead one to suspect, for the actual pneumonic change is small. The temperature rises abruptly, but falls by lysis rather than by crisis, and the rapidity of the resolution is remarkable.

Pulmonary Œdema.—Pulmonary œdema is rare, and, as described by French writers, occurs suddenly and unexpectedly in the mild cases. Such instances as I have met with have occurred in the severe forms of cardiac rheumatism. Sharp crepitations appear over the upper lobes in front, and then, if the condition is to prove fatal, quickly spread over the entire lungs. There is great respiratory distress, but in the early stage recovery is possible, and the crepitations may rapidly disappear.

It is a very interesting point that this œdema is probably not of mechanical origin, for it commences, as does the œdema in renal disease, in the upper lobes, and is more marked in these lobes after death. In connection with the occurrence of this œdema, it may be advisable to consider the possibility that intolerance of salicylates may be a factor in the causation.

NERVOUS SYMPTOMS.—*Chorea* in adult life is rare, though young women during pregnancy may suffer sometimes most severely, and those who have had a previous attack, or have suffered from other forms of rheumatic fever in earlier life, appear to be the most liable. In adults also a condition may be sometimes noticed, during an attack of rheumatic fever, which can hardly be termed chorea, but in which the voluntary movements are uncertain, sudden, and sometimes irregular. Finally, there are cases of chorea in early life which persist for many years, and which may be truly called chronic chorea.

Peripheral neuritis is an occasional event, and atrophy of the small muscles of the hand may sometimes reach an extreme degree. In some cases muscular atrophy and arthritis combined produce a condition very closely resembling acute rheumatoid arthritis.

Hyperpyrexia; Cerebral Rheumatism of the French Writers.—This is the most fatal event that occurs in an attack of rheumatic fever, but is fortunately rare.

The rapid rise of temperature to such a limit as 108°, or even higher, forms the most striking feature, but the cerebral symptoms are also very remarkable, and they may occur before the temperature has reached a great height. There can be little doubt that behind these conditions there is some underlying cause which accounts both for the cerebral symptoms and the hyperpyrexia. Headache, restlessness, and insomnia may be the early symptoms. Sometimes much urine is passed, and the pain in the joints may disappear and sweating cease. Later, delirium, coma, muscular tremors, and involuntary evacuations occur, and death may follow general convulsions. The temperature may rise with extreme rapidity, or after maintaining a high level for some days suddenly rise beyond the limits of safety. The condition is always one of extreme danger, and one which requires prompt and decisive treatment.

Angina Faucium.—There is no characteristic sore throat, but the most common type is probably the one described by Fernet, and quoted by Dr. A. E. Garrod in his treatise on rheumatism: "A diffuse erythematous redness is seen to occupy the whole of the back of the throat, and some œdematous swelling of the mucous membrane is present, which is most marked about the uvula, which is swollen and elongated. The pharynx is moist and free from all exudation; one or both tonsils may present more or less considerable swelling." The throat is one path of infection, but it would be unwise to claim it as the only one; at the same time, if inflammation is to be looked upon as an effort of resistance, it may be well to point out the possibility of a virulent infection by this channel without the occurrence of pain and inflammation. Such an occurrence in other infections —puerperal fever, for example—is thoroughly recognised. The infection may be terribly virulent, but local changes practically absent.

Peritonitis.—When we consider the frequency of pericarditis and pleurisy, it is interesting to find the rarity of peritonitis; but though rare, the occurrence is undoubted, and with the other symptoms of this condition loud peritoneal friction may be occasionally heard.

Acute dilatation of the stomach may follow rheumatic fever, and the digestion is often enfeebled for some time after a prolonged attack.

Appendicitis has been traced to rheumatic fever, and among others Dr. Burney Yeo, Dr. Sutherland, and Dr. Beverley Robinson have supported this view. It is very difficult to trace a definite connection between these diseases, and the subject is the more difficult because there sometimes arises in connection with appendicitis a septic arthritis which may closely resemble the arthritis of rheumatism.

RENAL AFFECTIONS.—*Nephritis,* though not common, has been observed by competent authorities, and it is very probable that the kidneys are often damaged by repeated attacks of rheumatic fever, without that damage reaching the stage of an actual nephritis. Rheumatic fever may in this way assist in the production of that condition recognised in later life as "granular kidney."

Albuminuria sometimes occurs, and if there is infarction, hæmaturia.

Hæmaturia may occur also without any evidence of infarction in some malignant types of the disease to which Prof. Litten has especially directed attention.

Subcutaneous Nodules.—Subcutaneous nodules sometimes occur in adults over the bony prominences and along the sheaths of tendons. In some seasons these nodules are far more common than in others, and it is then they are most liable to be found in adults, and it is then also they may occur without severe cardiac disease, which, as Dr. W. B. Cheadle has insisted, is the usual accompaniment. Myalgia may be a troublesome symptom in an attack of rheumatic fever, when the joints in the proximity of the muscles show no signs of inflammation.

CUTANEOUS MANIFESTATIONS.—Although much clinical information has been obtained upon the skin affections, there is still a good deal of obscurity around the subject, on account of the difficulty in determining which of these lesions are truly rheumatic.

Among the acute affections the erythemata and purpura are well recognised, and if some forms of psoriasis and scleroderma are accepted as rheumatic, these would represent skin affections of the more chronic type.

The erythemata are classified according to their characters as erythema, marginatum, papulatum, bullosum, and nodosum.

The first two are also included under the term erythema multiforme.

The marginate form appears in circles of various sizes, often called by the patient "ringworms," the dull pink colour of which quickly changes in the centre to a livid hue. The circles often coalesce, and thus are formed gyrate patterns which fade and leave a dull stain. In association with these forms of erythema purpura is not uncommon, and occasionally a subcutaneous nodule appears in the centre of a patch.

In the papular forms the areas are raised, usually symmetrical, and often show a slight bruising. These eruptions, except for some smarting, give rise to little discomfort. In rare cases there is extensive purpura without the occurrence of hæmorrhages from the mucous surfaces, and sometimes large sanious bullæ may be formed. If the process be closely watched, erythema is found to precede this purpuric condition, but the change is rapid and very complete. When these stages are passed through very rapidly, and there is active rheumatism as well, that condition of purpura results which may be truly called rheumatic, but there are other forms of purpura associated with arthritis which it is difficult to feel confident are truly rheumatic.

Erythema nodosum is a remarkable affection, in which intensely tender nodes appear most usually over the shins, but also over the fore-arms, thighs, and elsewhere. At first they are a bright pink colour, later they are a dull red, and may pit on pressure, and finally they leave for a while a bruise-like stain. In rare instances subcutaneous nodules occur which differ considerably in their distribution from rheumatic nodules, and over which the skin is not discoloured.

Whether erythema nodosum is rheumatic is still much disputed, and the question cannot be said to be definitely settled. At present it is perhaps the safest plan to make a compromise, and say some cases are rheumatic and some are not; for, on the one hand, the late Dr. Begbie, Dr. Stephen Mackenzie, Dr. Cheadle, and others, have brought forward good evidence of such an occurrence in rheumatism. On the other hand, competent authorities have given good reasons to show that it may occur quite apart from rheumatic fever.

Dr. Goodhart and others have looked upon psoriasis as a rheumatic affection, and there seems excellent reason for this belief. Scleroderma is so rare that it is difficult to prove the association, but Dr. Ball, Sir Dyce Duckworth, Dr. Crocker, and others, have brought forward clinical evidence in its favour.

Urticaria is believed by many to be a rheumatic manifestation, and Dr. A. E. Garrod has noted that in some cases a localised œdema may replace an urticarial or erythematous eruption.

It is not unlikely that the sudamina of rheumatic fever are rheumatic manifestations.

EXOPHTHALMIC GOITRE.—Dr. Samuel West has drawn attention to the frequency with which a history of rheumatic fever is obtained in these cases. The association is a very remarkable one of which I have seen several instances. In rare cases inflammation of the thyroid gland has been observed.

Conjunctivitis and iritis appear to be rare, and there is doubt whether the latter ever results from rheumatic fever. I would venture to throw in my opinion with those who believe there is a true rheumatic iritis.

THE DIAGNOSIS OF RHEUMATIC FEVER

When the diagnosis of rheumatic fever is considered, we are struck with the great change that has taken place in the views upon arthritis. The investigations of bacteriologists have demonstrated that arthritis is a result of many and various infections: the mention of tubercular, pneumonococcal, streptococcal, staphylococcal, and gonococcal arthritis in addition to the rheumatic form is sufficient to exemplify this, and in each case it is admitted that the arthritis is a manifestation of the disease, and not the disease itself. No doubt the arthritis in each instance often presents some peculiarity in its course, as does the disease which is the cause, but an attempt to found a diagnosis upon some minute detail of morbid anatomy is no longer relied upon as satisfactory.

It is to be hoped that some means will arise by which the diagnosis of rheumatic fever can be pushed, as it were, a step farther back. Those symptoms which we now look upon as only suspicious, will then be recognised as certain indications, and there will result a greater likelihood of forestalling the cardiac complications. The infective view of the disease holds out a promise that this advance will be made, and although it is not likely that the morphological characters of the diplococcus will assist in the diagnosis, some peculiarity in the cultural characteristics may eventually prove of great service.

At present the difficulty in the early diagnosis is to separate rheumatic fever from other acute fevers, and in particular from scarlet fever, influenza, and enteric fever when there is arthritis early in the illness. Acute osteomyelitis may lead to a serious error. Again, when tonsillitis occurs, it is difficult to say whether this is a local affection only, or a manifestation of the more serious disease. It may, indeed, be necessary to suspend judgment for a time, but if all the facts of the illness are carefully weighed the delay is usually short.

Later, when arthritis has already developed, a broad survey is taken of the entire case: the age, the family history, the character of the arthritis, the implication of the heart, the occurrence of subcutaneous nodules. All these and other points as well are studied, and then in most instances the diagnosis is easy.

Rheumatoid Arthritis.—In the present state of our knowledge of rheumatoid arthritis, it is difficult to lay down any sure rules for diagnosis, and it is quite probable that some of these cases are really examples of inveterate rheumatic arthritis. On the other hand, an insidious disease, which, according to Mr. Jonathan Hutchinson, is most common in delicate women of gouty inheritance, in which intractable progressive arthritis, often curiously symmetrical, is accompanied by great muscular wasting, and in which functional rather than organic disease of the heart is the rule, points to that form of joint affection which is called rheumatoid arthritis. The weight of the disease falls in these cases upon the joints, the muscles, and the nerves, and, though it is a rule by no means without exception, the heart is spared the severe inflammations of rheumatic fever.

Rheumatic Fever and Gout.—I feel that to speak of rheumatic gout is to be guilty of something of a heresy, but presumably there can be no reason why the rheumatic infection should not attack a gouty person. If it be allowed that it is the tissue metabolism in gout which is peculiar, then it is highly probable that the rheumatic infection will be modified by the peculiar soil in which it has gained a foothold, and a condition will result which is rheumatism in a gouty subject. On the other hand, a patient who has suffered from rheumatism in early life may so live in his adult life as to become gouty, and gout in a rheumatic subject may be also modified in its character. The tendency is for the arthritis in these cases to be unusually obstinate. In lead workers who have suffered from undoubted rheumatic fever, a condition of arthritis in later life is seen which is called gout—a condition far more intractable than the usual rheumatic arthritis, yet not infrequently called gout, chiefly because the patients were workers in lead.

Pyœmic Arthritis.—In severe cases of suppurative arthritis, rigors, high irregular fever, delirium, and rapid prostration are usual. But there is a group of cases vaguely termed "septic" which do not run this severe course, and which, if we judged by arthritis only, would be very difficult to separate from rheumatic arthritis. Such cases require further elucidation. Again, there is a form of pyæmic arthritis met with in drunkards whose constitutions are shattered, in which the temperature does not range high, and may indeed even be subnormal for a time. The joints are swollen and tender, there are tremor and wandering of the mind at night. The pulse is feeble, and the extremities are cold. To mistake this condition for rheumatic fever is a serious error, for it is invariably fatal, and the end comes with great rapidity.

Gonorrhœal Arthritis.—The diagnosis in this case rests chiefly upon the occurrence of a urethral discharge, or a history of a recent attack of gonorrhœa. The heart is rarely affected, and conjunctivitis and iritis are much more frequent occurrences than in rheumatic fever.

Traumatic arthritis is usually monarticular, and there is a definite history of injury to serve as a guide, but it should be borne in mind that in rheumatic fever there may occur an arthritis of one joint only. Errors may then easily arise. The patient may say, "I have sprained my ankle," and his diagnosis be too readily accepted, when a more careful search would have discovered fever, and perhaps inflammation of the heart. Acute monarticular rheumatism of the right hip joint may be mistaken for appendicitis.

The arthritis that follows dysentery and other ulcerations of the colon in the early stages resembles a pyæmic arthritis in its severity, and with it there may be extreme muscular wasting, nevertheless the recovery is often very remarkable. The diagnosis rests chiefly upon the history of the disease from which the illness has dated. With tubercular, syphilitic, and pneumonococcal arthritis, the same broad survey of all the facts must be taken in arriving at a conclusion.

Allusion may here be made to the value of the salicylate treatment as a diagnostic aid. The rapid way in which many cases of rheumatic polyarthritis subside under this treatment is an undoubted assistance in diagnosis, but it is far from certain that we are justified in making the result of this treatment a complete test of the rheumatic nature of a doubtful case. The action of salicylates is so little understood, and nature of the rheumatic processes at present so mysterious, that it seems hazardous to build up a disease on such evidence, however strongly the practical convenience of it may appeal to us.

The Prognosis of Rheumatic Fever

It is very rarely that a patient does not recover from a first attack of rheumatic fever, though hyperpyrexia occasionally supervenes and proves rapidly fatal, and in exceptional cases carditis has been the cause of death. In the vast majority of cases recovery occurs, but it is unfortunate that this recovery is often incomplete, and even more unfortunate that one attack does not protect in the future.

The prognostic indications of the various heart affections are dealt with in the articles devoted to those diseases. Here we are only concerned with the prognosis of acute rheumatism, for which only general rules can be given. The younger the patient, and the more pronounced the hereditary tendency, the greater fear there is of a future attack, and this fear will be enhanced if the circumstances are poor and the surroundings unhealthy. Repeated attacks of rheumatic fever in early life usually leave some organic heart-disease behind them.

The occurrence of pericarditis, pleurisy, and pneumonia point to the virulent types of the disease, and subcutaneous nodules, as Dr. W. B. Cheadle has insisted, are additional proof of this, although, as mentioned earlier in the article, there are some exceptional instances.

The supervention of the malignant type of endocarditis is extremely grave, and such cases seldom recover. The persistent types of subacute rheumatic fever, in which pericarditis and other manifestations appear from week to week and month to month, are of bad prognosis, and it would seem that when the health of the patient has been long undermined by the rheumatic processes, and the mechanical difficulties of chronic valvulitis, a condition is reached in which active rheumatism smoulders on unaffected by any methods of treatment. On the other hand, many cases of articular rheumatism, especially in adults, recover completely, and even if valvulitis has resulted, the mitral incompetence is often so slight as to produce no tangible injury to health, provided there are no further attacks of rheumatic fever. Pericarditis is justly dreaded, but there is good reason to suppose that recovery from this may sometimes be complete. As a rule the joints recover completely, and, even though pain and stiffness remain for some while afterwards, assiduous treatment will generally meet with success. There are exceptional cases in which deformity results and remains permanent. Such cases, though they resemble rheumatic fever in their varied manifestations, are, in the character of the changes in the joint, more akin to rheumatoid arthritis.

The prognosis in hyperpyrexia is very grave, but the prompt treatment by cold baths has made it far more favourable than it used to be.

The Treatment of Rheumatic Fever

Although there is no method of treatment which is generally recognised as specific, it is a disease which skill and care can do much to alleviate. The tendency that there is to natural recovery makes it especially difficult to ascertain the amount of improvement that directly results from treatment by drugs, and as a result many different remedies have been used and later abandoned. There seems little doubt that some manifestations respond to treatment better than others, and that of these arthritis is the most, and carditis the least amenable. Experience has shown also that depleting measures, such as free venesection and hard purging, are out of place in the management of rheumatic fever.

Prophylaxis.—It is only within recent years that the great importance of the early warnings of rheumatic fever have been insisted upon, and the prophylactic treatment can hardly yet be said to have developed. The search for suitable climates for rheumatic children, for the paths of infection, and for the methods by which infection may be avoided, will very probably lead to good results. And the influence of bad sanitation on the occurrence of rheumatic fever seems especially worthy of attention.

Treatment of an Attack of Rheumatic Fever.—*General Measures.*—Rest in bed is the remedy that at present stands first, and has been insisted upon by all the greatest teachers upon the treatment of the disease.

Strong nurses are required when the patient is an adult, for the pain on movement causes complete helplessness, and the ineffectual efforts of a nurse, however skilful, who is physically unable to lift the patient properly, is an additional cause of suffering.

The bed should be strong and firm, the height a convenient one, and the breadth not so great as to make the patient difficult to move from either side.

On account of the profuse sweating he should lie between blankets, and these can now be obtained of such softness as to be suitable for the more delicate skins.

Lastly, the bed-gown should be of flannel, and by means of suitable tapes should allow of an inflamed joint being easily reached. When the sweating is very profuse, occasional gentle drying with a soft warm towel is grateful, and helps to diminish the unpleasant odour which is so frequently noticed.

Local Treatment.—Hot dry wool is a very useful routine application, and plenty of this should be gently bandaged around the joints, or if wool cannot be obtained, fine sand or salt baked until dry and placed in suitable bags make good alternatives.

Opium and belladonna liniment, warm alkaline lotions, and hot fomentations can be used, though the aim should be, as far as possible, to avoid frequently disturbing the limb.

When the pain in one joint is excessive, plaster splints are useful for keeping the limb absolutely at rest.

Cold applications are not so generally useful, and though blisters or a light touch with the cautery are of great service in chronic arthritis, these are not so suitable when many joints are affected with acute inflammation.

When the joints remain stiff, weak, and painful after an acute attack, gentle massage, dry heat, and hydropathy are indicated, and the compound mustard liniment, though unpleasant, is a useful aid in relieving pain when the more expensive methods are out of the question.

Diet.—The diet during an acute attack should be light and nourishing, milk diluted with a mineral water or barley water, light soups, and later farinaceous foods, given at regular intervals. Strong soups, and the many patent meat preparations, although they are stimulating, throw a strain upon the kidneys which in acute rheumatic fever is better avoided.

When the attack is less acute the diet need not be so rigid. It is difficult to explain the reasons for the strong objection there is to the use of animal foods in rheumatism, but physicians of wide experience have insisted that relapses are favoured by their use, and that they have had cause to regret a concession to the patient upon this point. Much probably depends upon the character of the attack, and there can be little doubt that in the protracted and asthenic type in which the temperature is but little raised, a generous diet is better than a restricted one.

If, on the other hand, in a strong adult the diet has been limited, the return to meat and ordinary meals must be gradual, for the digestion is considerably impaired by the disease. The use of alcohol is not required unless there are indications of cardiac failure, and the physician will then be guided by such indications as hold good in the treatment of diseases of the heart.

TREATMENT BY DRUGS.—*The Salts of Salicylic Acid and Salicin.*—These drugs are very widely used, especially in the treatment of the arthritic type of rheumatic fever.

First introduced by Dr. Maclagan into England, they have undoubtedly proved of great value, and have relieved an immense amount of suffering; under their influence the pain of the arthritis is rapidly eased, and the temperature falls, but the severe rheumatic affections, such as pericarditis and endocarditis, do not seem to respond in the same striking manner, and nodules may increase in size and number while full doses are being taken. Many believe the action of these salicylates is specific, but it appears certain that in severe rheumatic pericarditis this specific action cannot be clearly recognised when doses are given within the limits of safety.

They may be used to arrest a threatened attack of rheumatic fever, to control the developed disease, and to prevent relapses.

It is in the earlier stages, before definite arthritis or endocarditis has developed, that we should be led to expect the best results from their use, but it is difficult to feel sure at such an early stage that the attack would have developed into the pronounced disease. There is, nevertheless, in this early stage good reason to suppose that they are of value. When the disease has fully developed, it is generally agreed that the drugs should be pushed in full doses for a short time to get the patient rapidly under their influence. Some authorities, having achieved this object, stop them abruptly; others gradually diminish the dose and increase the intervals between them. The latter course appears to be the more satisfactory. If, then, we suppose a strong adult suffering from an acute attack of arthritic rheumatism, the bowels should be opened by an aperient, and twenty-grain doses of salicylate of soda be given every two hours until the temperature falls and the pain is relieved, then the interval be increased to every four hours, and later the dose gradually diminished. When the temperature and arthritis have been subdued for about ten days salicylate of quinine can be given, and finally quinine in an effervescing alkaline draught be substituted.

Unfortunately there are some difficult questions that must be faced in the use of this method. The salicylates have been widely looked upon as depressant to the heart, and their efficacy in rheumatic carditis doubted. Should we, then, adopt this treatment in preference to others, when there is pericarditis or other clear indications of active and severe heart-disease? It is, indeed, a momentous question, and one which, in the face of the antagonistic views of physicians of wide experience, may well be answered with hesitation.

Further, it must be allowed that the quality of these drugs has been improved of recent years, and that, as Dr. D. B. Lees has pointed out, some part of the depressant action which has been ascribed to them is really the result of the rheumatic poison upon the heart wall. But until more convincing evidence has been given of the specific action of these drugs in rheumatic carditis, it is, I believe, safer not to push them when there is active heart-disease, but if there be distress from a coincident arthritis, to use them then in moderate doses to control the pain.

Another answer to the objection that they are depressant, may be that though this is true of their action upon the normal heart, such is not the case when the heart is affected by rheumatic fever, because their action is specific. It is difficult to answer this contention, for both the action of the disease and of the drugs—if they are depressant—tend to cause cardiac failure. Those, then, who favour their use are apt to ascribe acute cardiac failure to the disease, those who hold them to be depressant will attribute it to the drugs. It appears to me that they are depressant to the heart in active rheumatic affections, as they are to the healthy heart, and that their use in full doses in acute carditis is hazardous. Pallor of the face, dangerous vomiting, air hunger, and rapid cardiac failure, are symptoms which, if they develop acutely in a case of rheumatic carditis, treated by this method would suggest to me the toxic effects of the drug rather than of the disease.

Those cases in which there is obstinate relapsing rheumatism of the joints are often benefited by the prolonged use of moderate doses of salicylates.

The particular preparation that will be given in any case differs with the practice of the individual prescriber. The most effectual, though more expensive drug, is the natural salt. A milder preparation, useful for delicate persons and children, is salicin, but a good sample of salicylate of soda will, in most cases, answer every purpose, and the taste is well covered by spirits of chloroform and tincture of cardamoms. There are exceptional cases in which moderate doses will cause delirium, deafness, and vertigo. A comparatively new preparation, acetyl-salicylic acid, or aspirin, has come into use, and is claimed to stimulate the heart and to avoid any nervous symptoms. It has yet to stand the test of experience. The drug may be prescribed with syrup of lemons in doses from 5 to 20 grains.

Before the treatment with salicylates was generally adopted, large doses of alkalies were believed to be of value, and this method of treatment still retains to some extent the confidence of the profession. If they are not used alone they are often combined with the salts of salicylic acid. The citrates, bicarbonates, and acetates of potash are the most frequently administered, and when this method is pushed, half a drachm of bicarbonate of potash and the same of the citrate are given in an ounce of water, every four hours, until the urine is alkaline. When this has been done, the urine is kept slightly alkaline by gradually diminishing the amount of these drugs, and the treatment is persisted in until the symptoms abate. Later quinine may be added. The effect of this treatment must be carefully watched, for it may prove too depressant if the circulation is feeble, and with some patients these large doses of alkalies cause severe diarrhœa.

The view that rheumatic fever is the result of an infection brings into prominence the importance of the constitutional resistance. This factor is a very important one in this disease, and one of which there is danger of losing sight, if exclusive attention is directed to the effect of the disease. Energetic and routine treatment by powerful drugs may damage this resisting power of the individual more than they influence the disease. With opportunities of studying different methods of treatment, it has appeared to me that in the dangerous and complicated cases of visceral rheumatic fever the best results are obtained by palliative measures; rest, careful feeding and nursing, moderate doses of salicylates for pain and arthritis, stimulants for cardiac failure, small doses of opium for cardiac distress and insomnia, mild tonics for convalescence—in brief, a watchful but gentle treatment. Under such measures some of the most desperate cases have rallied, and fewer, I believe, have gone to the bad with the sudden development of urgent symptoms.

Since there is so much evidence to show that the tonsils may be a site of infection, the treatment of the throat is important, and will be carried out on general principles. A gargle containing salicylate of soda may be used, or glycerine of carbolic acid, or formalin, and some have advocated guaiacol as especially valuable. In spite of this treatment of the throat, the diplococci in the other local lesions may doubtless multiply, and no treatment of the throat alone can suffice.

Repeated attacks of tonsillitis may result in a permanent enlargement for which tonsillotomy may be needed. The operation, though needful for the general health, will not prevent further attacks of rheumatic fever, and on several occasions to my knowledge an attack has rapidly followed this operation, though presumably these were coincidences.

Otitis media, with which an attack of rheumatic fever may sometimes begin, must be treated on the usual lines.

For the Treatment of Hyperpyrexia (*vide* art. "Hyperpyrexia")

No time should be lost in giving antipyretic drugs, but the patient should be placed in a bath at the temperature of 65° with ice applied to the head, and the water rapidly cooled by adding blocks of ice. If the temperature of the patient is, for example, 107°, when it has dropped to 102° he should be taken out, rapidly dried, and wrapped in a blanket. As a rule the temperature will continue to fall for a while, but should it rise again this treatment must be repeated. It is a severe remedy for a desperate condition, and throughout the time of immersion the patient must be most closely watched, and be removed if there are signs of collapse, and stimulants freely administered. If the temperature should fall below normal after removal, hot bottles must be placed round outside the blanket, and stimulants given. Ice-packing is valuable when a bath cannot be managed. A sheet is wrung out in iced water, the patient swathed in it, and then rubbed with blocks of ice. The effect must be closely watched, for it is a drastic remedy.

When convalescence has been established, the question arises as to the length of time complete rest should be insisted upon. Much must depend upon the condition of the heart and the character of the attack. The guiding rule is caution, for premature exertion appears to be especially liable to cause a relapse. On the whole, it is better to be free from any arbitrary time limit, for this introduces the danger that when this time is past the patient will throw caution to the winds. If the pulse, the temperature, and the threatenings of active rheumatic manifestations are taken as guides, the return to an active life can be gradually attained, and every forward step carefully tested. The tedious nature of the illness makes the patient chafe at the enforced rest, and considerable tact in the graduation of the amount of physical exertion is required from the medical attendant.

The opposite danger, that of prolonging too much the period of rest, is also a real one. An invalid life is fostered, and in the young to whom movement is a natural tonic needless confinement is positively harmful.

When recovery is completed, and if expense is no object, it is well for the patient to leave England during the next year for a dry, warm, and equable climate during the autumn, winter, and early spring; and if a child, great care, especially during the autumn, will be necessary for some years to come. Warm clothing, warm socks, and thick boots are very necessary for rheumatic subjects in cold and damp weather, and woollen garments should be worn all the year round.

There remains the question of tonics. Strong preparations of iron, although there may be considerable anæmia, are not well borne. Quinine and arsenic in alkaline solutions, the milder preparations of iron, or the time-honoured prescription of ammonia and bark, are more useful.

An Antitoxin Treatment.—It is a natural hope that in future some antitoxin may be found which will be serviceable in treatment, and already antistreptococcic sera have been used. Unfortunately, treatment by antitoxins, except in diphtheria, have not yet met with wide success, and rheumatic fever with its numerous local lesions differs widely from that disease. Further, the greatest caution will be needed in judging of the value of such treatment, for, on the one hand, rheumatic fever naturally tends to recovery, and, on the other, the various members of the great group of micrococcal infections are not yet clearly differentiated from one another. But it would be unwise to prophesy on this matter.

In conclusion, I am indebted to my colleague, Dr. A. Paine, Bacteriologist to St. Mary's Hospital, London, for permission to make free use of our joint investigations upon which the details of the bacteriology and histology in this article are based, and which have enabled me to treat confidently of rheumatic fever as an infective disease.

LITERATURE.—The literature upon this subject is so vast that a bibliography in such an article as this would be impossible. Some important references are given below, and those who are especially interested in the subject will find many others in Nos. 3, 8, and 9 of those given below.—1. Barlow, T. "Rheumatism and its Allies in Childhood," *B. M. J.* 1883, ii. p. 509.—2. Cheadle, W. B. *On the various Manifestations of the Rheumatic State as exemplified in Childhood and Early Life.* Harveian Lecture, 1888.—3. Garrod, A. E. *A Treatise on Rheumatism.*—4. Litten. *Berliner klinische Wochenschrift,* 1899, No. 29, p. 644.—5. Lees, D. B. "Acute Dilatation of the Heart in Rheumatic Fever," *Trans. Royal Medical and Chirurgical Soc.* 1898.—6. Maclagan. *Lancet,* 1876, i. p. 342.—7. Mantle. "The Ætiology of Rheumatism from a Bacterial Point of View," *B. M. J.* 1887, p. 1381.—8. Meyer, Fritz. *Deutsche med. Woch.* 1901, Feb. 7; "Zur Bakteriologie des acuten Gelenkrheumatisme," Separat Abdruck aus den Verhandlungen des XIX. Congresses für Innere Medicin.—9. Poynton and Paine. "Etiology of Rheumatic Fever, etc.," *Lancet,* Sept. 22-29, 1900; *Path. Soc. Trans.* vol. lii. part i. 1901; *Practitioner,* Jan. 1901; *Lancet,* March 12, 1901; *Lancet,* May 4, 1901; *Path. Soc. Trans.* vol. lii. part iii. 1901; *B. M. J.* Sept. 1901.—10. Lees and Poynton. "Acute Dilatation of the Heart and the Rheumatism and Chorea of Childhood," *Trans. Royal Medical and Chir. Soc.* 1898.—11. Triboulet and Coyon. *Le rheumatisme articulaire aiguë.* Paris, 1900.—12. Westphal, Wassermann, and Malkoff. *Berliner klinische Wochenschrift,* 1899, No. 29, p. 638.—13. Wilson. "On a Case of Rheumatic Pericarditis in which a Micro-Bacillus was found," *Ed. Med. Journ.* 1885, xxx. p. 1105.

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There is a considerable difference in the manifestations of rheumatism as ordinarily seen in children and those occurring in the same complaint in adults. In both there is the same difficulty in defining what symptoms may or may not with any degree of precision be classified as rheumatic, and the younger the patient the more this difficulty is enhanced. In what is known as acute rheumatism, or rheumatic fever, in adults, with the high temperature, the profuse, sour-smelling perspiration, and the swollen and acutely painful joints, we have a complaint with well-defined symptoms, admitting of but little doubt in their interpretation or diagnosis. Such a combination of symptoms is very rarely seen in young children, and it is only towards the age of puberty that rheumatism in them takes on the adult type. In the complaint, as ordinarily seen in children, the temperature seldom rises above 101° without definite tonsillitis or pericarditis be present; the skin, instead of moist, is usually dry; pain is generally much slighter than in adults, and if there be any recognisable arthritis, it is slight in degree, and very rarely accompanied by any redness of the affected joints. Such terms as acute and subacute have but little significance or propriety when applied to rheumatism in childhood. Distinguishing features of rheumatism in children, as compared with the disease in adults, are usually much slighter degrees of arthritis, the greater tendency to the occurrence of skin eruptions and subcutaneous fibrous nodules, and the much greater frequency of cardiac complications, and this last in spite of the often seemingly trivial character of the preceding or accompanying symptoms. There is also a tendency for some one single symptom to assume such prominence that the others are apt to be obscured. Stress must be laid upon the disconnected and apparently trivial outward phenomena of the complaint, as a correct diagnosis is all-important, having due regard to the frequency and gravity of the associated cardiac complications.

PATHOLOGY.—This is the same undoubtedly as that of the complaint in adults, and rests on the same obscure basis. The theory that the disease is due to lactic acid in the blood has little or nothing to support it. The malarial origin of rheumatism, based mainly on the effects of the salicylates in controlling it, can hardly now be advanced in the face of modern discoveries regarding malaria. For the view, once widely held, that rheumatism was dependent upon some impression on the nervous system there is still much to be said, although the arguments adduced in favour of it never advanced beyond pure hypotheses and suggestions. At present the theory that rheumatism is of bacterial origin is the one most in vogue, and various forms of micro-organisms, chiefly streptococci, have been isolated from the blood and other constituents of the body from sufferers with it, and the claim is put forward that they are the cause of the disease. The uniform relation often obtaining between the development of arthritis and crops of subcutaneous nodules and a previous sudden rise of temperature lend further support to the bacterial theory. Allowing all this, however, and acknowledging the excellence and importance of the recent work of Poynton and Paine, it cannot be claimed that the bacterial origin of rheumatism is conclusively proven. Their experiments require repetition and confirmation by themselves and others before being accepted as definitely conclusive. Many of the pathological changes produced in the endocardium and other structures of rabbits through the agency of the special diplococci, which they regard as one of the existing causes of rheumatism, have been asserted by equally competent observers to occur in the same animals by means of several other micro-organisms. Moreover, it is difficult to explain the sudden onset of certain manifestations, presumably rheumatic in character, that come on in persons subject to rheumatism, either directly after, or indeed simultaneously with, the exposure to cold or damp, on the assumption that the complaint is one of bacterial origin. Where all is so unsettled there is no need to discuss the question at any length, more especially as it is treated of elsewhere in this volume (p. 443 *et seq.*)

ETIOLOGY.—Inheritance from father or mother is a powerful disposing cause, and this is largely increased when both parents are rheumatic. When one member of a family, too, has suffered from rheumatism, there is a much greater liability for the brothers and sisters to incur the complaint than the members of other families, even when there is no parental inheritance. That living in cold, damp, low-lying situations predisposes to rheumatism is beyond question, and of late it has been stated that dry hilly places exposed to bleak winds are equally unfavourable as regards the complaint. Males suffer more often than females owing to more frequent exposure to wet and damp, but apart from this, either sex under the age of ten is equally liable to the complaint. Between the ages of ten and fifteen, however, there is a marked preponderance of cases amongst girls, and this has been put forward as some explanation of the greater prevalence of mitral stenosis in the female sex. In temperate climates the disease is most prevalent in the spring. There is some evidence for believing that red-haired children are more prone to rheumatism than others. A very powerful factor in predisposing to the complaint is the fact of having suffered from a previous attack, there being no doubt that subsequent attacks are incurred with much slighter causes than those that occasioned the primary one.

Immediate exciting causes are exposure to prolonged damp and undue physical fatigue, a combination of these two, indeed, accounting for considerably more than half the total number of cases.

Age.—Probably no age is exempt from rheumatism. Cases with unmistakable outward signs in the joints, etc., are exceedingly rare under the age of two years, and rare under that of three years. After the latter age attacks occur more frequently with each year of life up to the age of ten years. Possibly more attacks occur during the second decade of life than any other, and it is uncommon for a primary attack to occur after the age of twenty. Owing to the slight character of the symptoms in infancy it is probable that the frequency of rheumatism at that age is underestimated, and it is not uncommon to see little children with cardiac lesions of some standing, presumably rheumatic in origin, but where the outward symptoms of that complaint had been so trivial at the times of attack as to be wholly overlooked.

Onset.—In older children this may be more or less sudden, with marked pyrexia and acute pains in the joints. Such an onset is very seldom present, however, in the younger subjects. In these there is almost invariably a history of indefinite pains in the joints, the knees in most instances at the start, and it is only after these pains have lasted several days, or even weeks, that an increase of them, or swelling of the joints, calls attention to the true nature of the attack, and compels the confinement of the child to bed. Rigors and other nervous phenomena that occasionally usher in the disease in adults are practically unknown in children under the age of puberty.

SYMPTOMS.—The isolated character of the symptoms in the majority of attacks in children, in contrast to the complex grouping of them that mark the more definite attacks in adults, justifies the plan proposed of dealing with each of them in detail. It is only in children, perhaps, that a confident diagnosis of rheumatism can be made from the presence of such isolated symptoms.

Pain.—This is almost invariably present, at some time or another, in every attack. In many cases, indeed, it is the only symptom complained of. It varies much in intensity and duration, but in both these particulars it seldom reaches the same height in children as in adults. It cannot be too carefully remembered that, in the vast majority of instances, the so-called "growing pains" of children are rheumatic in nature. It is far from uncommon to find advanced endocarditis in children in whom the only symptom of rheumatism has been these "growing pains." The history of "growing pains," too, often settles the rheumatic origin of many cases of chorea in the absence of other symptoms. When pain alone is complained of, the greatest care is necessary in ascertaining that it is limited to the joints before deciding that it is due to rheumatism, as in many febrile and other diseases children complain of vague pains in other parts of the limbs than the joints. The effects of passive movement may assist in this inquiry, but, for obvious reasons, cannot be definitely relied upon. When arthritis is present the pain is generally greater, and, indeed, it may be said in general terms that the amount and duration of the pain is directly proportionate to the extent of the arthritis. In some cases the pain is not limited to the swollen joints, but extends to the tendons of the muscles entering into their formation, and very exceptionally it can be unmistakably elicited by pressure over the nerves of the limbs away from the neighbourhood of the joints. Pain in the pericardium generally, but by no means invariably, attends the onset of pericarditis. Præcordial pain, too, may accompany the beginning of endocarditis, but more usually this occurs without any such accompaniment, and if any sensation be complained of in the region of the heart it is generally one of vague uneasiness rather than actual pain. Not very unfrequently pain in the region of the neck, causing "stiff neck," is the only outward sign of rheumatism, and this pain may occasion contracture of the muscles on one side (rheumatic torticollis). As many other complaints may cause "stiff neck," or torticollis, these last will have to be excluded before the diagnosis of rheumatism is entertained.

Sweating.—The profuse, sour-smelling perspirations of adult acute rheumatism are only occasionally observed in children. In these last, as a rule, the skin is dry instead of being moist. Any sweating that occurs is usually late in the complaint, and is perhaps due to the action of the salicylates rather than to some intrinsic character of the disease. In the intervals between the attacks, however, rheumatic children are very prone to profuse perspirations on the slightest exertions.

Arthritis.—As a rule, this is less severe and more transient in children than in adults. In both there is the same tendency to symmetry, and for the swelling to disappear from points earlier attacked to involve others. The knees, ankles, and wrists, in the order given, are the joints most often attacked. Not very unfrequently the metacarpal phalangeal joints are involved with the larger ones, and much less frequently the corresponding joints in the feet. Cases in which the smaller joints are involved are generally severe. The swelling of the joints concerned is seldom of any great extent, and it is only exceptionally that there is any redness of the adjacent skin. The amount and extent of the arthritis is a measure of the severity of the attack, and it is very seldom that rheumatism of such severity as to cause definite arthritis is not attended with pronounced cardiac lesions in children under seven years old. In children under that age, too, with a history of past arthritis, there is strong presumptive evidence that the joint affection was not rheumatic if the heart be free. The swelling seldom remains in any one joint for many days, but accurate knowledge of the duration is rendered uncertain by the efficacy of the salicylates in removing the external signs of the complaint. If the swelling persist in spite of treatment, and is limited to one or perhaps two of the larger joints, then a suspicion of gonorrhœa should always arise, as cases of gonorrhœal arthritis are by no means unknown in even little boys and girls. In children a chronic synovitis is never left as a consequence of rheumatism, and contractures and other deformities of the joints are perhaps unknown. Very occasionally the arthritis is confined to one joint, usually the hip, and it is not uncommon to find these mon-articular cases mistaken at first for tuberculous disease of the affected joint. Some degree of arthritis, or pains in the joints, is a feature of the complaint in by far the greater number of cases. The interest and importance attaching to the mon-articular cases have, perhaps, led to an exaggerated estimate of their frequency on the part of certain writers. But it is in the diminished severity of the arthritis, and not mainly in its diminished frequency, that one of the chief distinctions between the rheumatism of childhood and that of adult age lies.

Pyrexia.—This plays a much less conspicuous part in the rheumatism of children than in that of adults. In contrast with what occurs in other complaints, in rheumatism the younger the child the less the tendency for the temperature to be raised. In slighter cases, marked by joint pain only with no accompanying arthritis, the temperature may not be raised at all, and this in many instances where the effects upon the heart are disastrous in the extreme. On the contrary, again, fever is never the sole manifestation of rheumatism in children, any increase of temperature being invariably accompanied by pain or some other more definite sign of the complaint. In ordinary cases, with an average amount of arthritis, the temperature seldom ranges above 100° or 101° Fahr., without pericarditis or severe tonsillitis be present. With the onset of pericarditis the temperature may rise as high as 105° or 106°, and even higher still in cases where there is a combination of chorea with active rheumatism, manifested by such symptoms as pain and swelling of the joints. In cases such as the last pericarditis is almost invariably present as well. It is only in cases where pericarditis is present that we have in children any equivalent of the so-called "cerebral rheumatism" of adults, where the life of the patient is endangered from the pyrexia itself, independently of any other conditions. Much stress has been laid by some writers on the pyrexia consequent on endocarditis, but it can be safely said that any persistent temperature directly due to endocarditis is practically unknown with rheumatism in children. Any pyrexia that occurs is almost certainly due to the rheumatic symptoms that initiate the attack, and independent, probably, of any endocarditis that may ensue. Cases of endocarditis with persistent heightened temperature, where other sources of pyrexia can be excluded, should raise the same suspicion of malignancy in children as in adults, as although ulcerative endocarditis is rare in children, it is certainly far from unknown. An interesting phase of rheumatic pyrexia is afforded by cases where, after generally a sharp initial attack of fever, the temperature is persistently raised at some period of the day for many months, or even perhaps years. In such cases the temperature may daily reach 104° Fahr., but beyond causing occasional feelings of discomfort when high, the continued pyrexia seems in no way detrimental to the child. The only explanation of such a pyrexia would seem to be that here the rheumatic poison, whatever it may be, has made a profound impression upon the cerebral centres, and the delicate heat-regulating machinery has been thrown out of gear. Treatment has little or no effect upon the disorder, and time alone brings about the restoration of the calorific balance.

Tonsillitis is a very frequent symptom of rheumatism in children, especially at the onset of an attack. The frequency with which it occurs before any other symptom has led to the suggestion from the upholders of the microbic origin of the complaint, that the tonsils are often possibly the points of entrance of the poison into the system. The tonsillitis is seldom of any great severity, and a suppurative rheumatic tonsillitis is exceedingly rare in children. The temperature bears some relation to the degree of tonsillitis, being generally higher the more the latter is marked. In very exceptional instances cases of endocarditis have been noted where the only evidence of rheumatism has been tonsillitis. This should lead to a careful and repeated examination of the heart in all cases of tonsillitis of uncertain origin. There is nothing distinctive, however, in the outward appearances of rheumatic tonsillitis, and a case can only be pronounced rheumatic with any precision when other evidences of rheumatism are present. Besides ushering in acute attacks, tonsillitis often occurs in rheumatic children in the intervals between them. Such tonsillitis is often accompanied by slight anæmia and sweating on the slightest exertion. Such symptoms should be regarded as danger signals, and lead to a strict supervision of the child. It may well be, too, that repeated tonsillitis is evidence of the rheumatic diathesis, where there has been a total absence of the more definite signs of the complaint.

Pneumonia.—This is so infrequent in association with recent and active signs of rheumatism in children, as to render it doubtful if its occurrence has any direct causal relation with the rheumatic process. In the later stages of heart disease, however, it is not uncommon to find signs of consolidation, along with pleurisy, at the left base of the lung. The symptoms and course of such consolidations are generally different from those of a typical pneumonia, and are usually preceded by the signs of pulmonary congestion and œdema in the affected lung.

Pleurisy.—In contra-distinction to pneumonia, pleurisy is very common in the rheumatism of children, and may be the only evidence of the complaint. In exceptional instances it is the result of the direct extension of inflammation from the pericardium. The usual signs of it are pain over the lower ribs, and not unfrequently a pleural rub can be heard on auscultation. When directly due to the rheumatic process it is generally of the dry and plastic variety, and is very seldom accompanied by any noticeable amount of fluid in the pleural sac. Where it occurs, however, in the later stages of heart disease, along with consolidation of the lung, the amount of fluid poured out into the pleura may be considerable, and aspiration is often necessary to relieve the enfeebled and failing heart. An overwhelming proportion of such cases occur on the left side, but a satisfactory reason for this is still to be found.

Peritonitis.—It cannot be claimed that the connection between rheumatism and any form of peritonitis has been established with any exactitude. Any case where fibrous nodules have been discovered in the peritoneum, as with the pleura and pericardium, has yet to be noted. At the present day there is a tendency, perhaps a growing one, on the part of certain authorities to ascribe some cases of appendicitis to a rheumatic origin. But for appendicitis to develop in the course of acute rheumatism, or for rheumatic symptoms to develop during an attack of appendicitis, must be events of extreme rarity, and such cases are certainly not greater in number than mere coincidence could account for. The only evidence usually forthcoming for associating such cases of appendicitis with a rheumatic origin is the effect produced by salicylates upon the course of the abdominal complaint. These effects are mainly shown in the reduction of temperature, and not in the direction of any curtailing the course of the disease. But salicylates influence the temperature in many diseases apart from those of rheumatic origin, and until further evidence is adduceable beyond that furnished by their administration, the connection between appendicitis and rheumatism must be held to exist on an extremely feeble basis.

Nervous Affections.—So-called "cerebral rheumatism" or "rheumatic hyperpyrexia" is almost unknown in children, and the reality of a rheumatic meningitis, on which the hyperpyrexia was formerly supposed to depend, has yet to be proven by the publication of a single authentic case. Rheumatic children are very subject to headaches. These are often associated with anæmia, but in some cases Dr. Still (1) thinks the headaches have a more direct relation to the rheumatic poison. Goodhart (2), Graham Little (3), and several other authorities, find a strong connection between night-terrors and rheumatism, and Dr. Still (4) not only agrees with this, but thinks day-terrors, somnambulism, somniloquence, habit-spasm, and lienteric diarrhœa, are often associated with the same complaint. All these last disorders have probably no direct causal origin in the rheumatic poison, as cases of any one of them occurring along with active rheumatic symptoms are events of exceptional rarity. An explanation of the association of such nervous disorders and rheumatism is rather to be found in the "nervous" temperament, which is one of the most striking features in rheumatic children. As Dr. Still writes, "The nervous child is par excellence the nervous child." This is shown in some instances by an almost uncontrollable excitement over games and amusements, in some by excessive timidity, and in others by a sensitiveness or shyness which is almost morbid. One nervous disorder directly due to active rheumatism is peripheral neuritis, as evidenced by pain in the course of the nerves and subsequent wasting of the connected muscles. This is not so very uncommon, and would, perhaps, be more often found if systematically looked for.

Anœmia.—A profound degree of anæmia is very rapidly attained in the severe rheumatic attacks, and this may be very slowly recovered from. Along with the anæmia there is often considerable leucocytosis in the blood. In the intervals between more definite seizures, rheumatic children are prone to attacks of anæmia without any ascertainable cause. Chronic anæmia in rheumatic children is, perhaps, more directly ascribable to the frequently associated heart disease, but it becomes intensified with the onset of fresh symptoms of the complaint.

Wasting.—In the course of an attack of rheumatism there is often a rapid and marked loss of flesh, much greater than the pyrexia and duration of the illness would account for. It is true, too, perhaps, that thin children are more subject to rheumatism than those who are plump.

Subcutaneous Nodules.—Where so many of the other symptoms are inconspicuous and short-lived, too much importance cannot be placed upon the presence of subcutaneous fibrous nodules. In their typical forms and situations they are absolutely diagnostic of rheumatism, although it is quite possible that subcutaneous nodules may occur in syphilis, rheumatoid arthritis, and perhaps other complaints. Rheumatic fibrous nodules are small excrescences under the skin, varying in size from that of a pin's-head to that of about half a hazel nut. They may be solitary or numerous, but most often occur in crops, with a tendency to symmetry in their distribution. Very frequently their eruption is preceded by a rise of temperature three or four days beforehand. They are strictly subcutaneous, and the overlying skin is freely movable over them. As a rule they are movable over the underlying structures, but in places where the skin is closely adjacent to bone, as on the scalp and the neighbourhood of the patella, it may be difficult or impossible to separate the nodules from the adjoining bone. When very small, they can often be seen better than felt, by putting the overlying structures on the stretch. Their far most frequent situation is the back of the elbow joint. Very often it is the only one in which they are to be found, and cases in which they occur in other places without the neighbourhood of the elbow joint being affected must be exceptional in the extreme. For their detection, then, in the vast majority of instances, it is sufficient to flex the elbow joint and carefully examine the structures on the posterior surface. Subcutaneous fibrous nodules occur in many other regions than the neighbourhood of the elbow joint. They are not infrequent about the patella, the iliac crests, the pericranium, the spine and margins of the scapula, the skin over the spinous processes of the vertebræ, over the bony prominences of the hands and feet, and elsewhere. Besides these nodules in the subcutaneous tissues, nodular thickenings, homologous in nature with the last, are apt to occur in the tendons of the muscles, more especially in the flexor tendons of the wrists, the tendons about the malleoli of the feet, and the flexor and extensor tendons of the fingers and toes. Occasionally they are found in the tendinous expansions of the abdominal muscles. They are painless in themselves, but are sometimes tender to pressure.

Their presence in the scalp is often only detected by the comb catching on them when the hair is being dressed. Some vanish in the course of a few days, others persist for months, or even more than a year. Persistent nodules are often, or generally, accompanied by progressive endocarditis. Numerous nodules, and still more so nodules of large size, are omens of bad prognosis, and this out of all proportion to the extent any accompanying endocarditis may have attained. Subcutaneous fibrous nodules are invariably associated with cardiac disease, cases where they have been noted and there has been no demonstrable cardiac lesion being so exceedingly exceptional that they may be left out of account in dealing with the connection between nodules and morbus cardis. In cases where the heart has been healthy, the advent of subcutaneous nodules is almost invariably attended by the signs of recent endocarditis or pericarditis; and in cases where the heart is already affected, the onset of nodules is often accompanied by fresh additions to the heart symptoms, or an aggravation of those already existing. Considerations such as these lend strong support to the contention of Barlow and Warner (5) that bodies analogous to the fibrous nodules in the subcutaneous tissues form the basis of the vegetations in the cardiac valves in rheumatic morbus cardis. Further support of this view is afforded by the fact that bodies histologically identical with subcutaneous fibrous nodules have occasionally been discovered post-mortem in the cardiac valves. Not very infrequently fibrous nodules have been discovered in the thickened pericardium when the patient has suffered from rheumatic pericarditis during life. Much less frequently they have been found in the pleura and the fringes of the joints in cases of rheumatic pleurisy or arthritis.

Histologically these subcutaneous nodules are found to consist of fibrous tissue with some round or spindle-shaped cells, dilated blood-vessels, and a nearly homologous, more or less fibrillated "ground substance." This homogeneous substance has been shown to be a fibrinous exudation. These fibrous nodules are then, probably, the result of a local rheumatic inflammation. The invariable occurrence of other inflammatory manifestations simultaneously with that of subcutaneous nodules suggests that similar foci of inflammation to those occurring in the subcutaneous tissues may occur in the joints, the endocardium, pericardium, and the pleuræ. In these last situations the foci of irritation not only lead to the special form of inflammation attended by nodule formation, but to the ordinary forms of inflammation attended by serous effusion. Thus rheumatic arthritis, pleurisy, endocarditis, and pericarditis may originate in the same process that leads to the formation of subcutaneous fibrous nodules. It is their evanescent nature, probably, that prevents the more frequent discovery of these fibrous nodules post-mortem, not only in the subcutaneous tissues, but in other parts of the body.

As a rule the nodules disappear by a process of gradual resolution, getting smaller and smaller before their final disappearance. In exceptional instances this process is much hastened, and nodules of considerable size may disappear entirely in the course of a few days. As in the subcutaneous tissue, the nodules in the cardiac valves may disappear, and thus a cure be wrought occasionally in cases of organic cardiac disease. The hope afforded of such a chance is but a slender one. The shrinking and puckering of the delicate valvular structures secondarily to the inflammation attending the nodular eruption generally remains, however completely the nodules themselves may have resolved. Sometimes, instead of undergoing resolution, the nodules apparently become converted into fatty tissue. Over the point of the elbow it is not very uncommon for nodules to be succeeded by soft masses, like a small collection of fat, which persist long after the nodules elsewhere have disappeared. These apparently fatty tumours are generally about the size of a half hazel-nut, and the skin over them is often the site of an erythematous blush. Whether these soft masses are really fatty in character is as yet a matter of doubt, and hitherto their presence would seem to have escaped the notice of observers.

Occasionally the inflammatory process giving rise to subcutaneous nodules extends to adjacent periosteal structures, and periosteal nodes develop on the underlying bones. These rheumatic nodes have hitherto been only noticed when nodules are present, and generally the bony swelling is surmounted at first by one or more subcutaneous nodules. They usually persist much longer than the subcutaneous nodules, but have a tendency to gradually disappear in the course of time. The commonest site for such nodes is the subcutaneous surface of the ulna, and the nodes here generally have their long diameter in the direction of that of the limb. Still larger nodes, up to the size of half a walnut, may appear upon the skull where the overlying scalp has been the site of subcutaneous nodules; less frequently than on the ulna and the scalp, rheumatic nodes develop on the surface and edges of the patella. They have been noticed, too, on the subcutaneous surface of the tibia, but are probably much rarer here than in the other mentioned places, from the fact that subcutaneous nodules very seldom occur over the surface of the tibiæ. It is quite conceivable, too, that rheumatic periostitis may occasionally arise in places not amenable to inspection from a primary form of inflammation in the periosteum itself, independently of any direct extension of inflammation from adjacent subcutaneous tissues. It is not very uncommon in cases where fibrous nodules are present, especially nodular thickenings in the tendons, for ganglia to develop about the wrists. Such ganglia are doubtlessly due to an inflammation of the sheaths of the tendons. Very occasionally several nodules become welded together by inflammatory exudation, and move together as one mass under the adjacent skin.

Fibrous nodules are undoubtedly most common in cases where arthritis and other of the more definite signs of rheumatism have been present. They have occasionally been found in cases of chorea and stiff neck, and certain skin eruptions where careful inquiry has totally failed to elicit any history of previous joint affection. Such cases are, however, exceedingly rare, and their number has perhaps been over-estimated by too enthusiastic contenders for the pan-rheumatic origin of chorea.

There is no single phase of rheumatism in children in which subcutaneous fibrous nodules have not occasionally been found. They are far most frequent in cases where definite arthritis is present, and Dr. Still (6) found nodules in nearly 50 per cent of cases of articular rheumatism in children. They are next most frequent, perhaps, in cases where joint pains have been a prominent feature, but where the joint affection has not been of sufficient severity to lead to articular swelling or redness. In all cases of unmistakable rheumatism in children, nodules will be found in the early stages of the attacks in from 20 to 30 per cent of cases if systematically looked for.

Skin Affections.—These are comparatively rare, but are relatively much more frequent with rheumatism in children than in adults. Sudamina and miliaria have no direct association with rheumatism, and are perhaps less seldom seen in that complaint than in others where there has been pyrexia. The eruptions most commonly seen are various forms of erythema, and these may appear simultaneously with other rheumatic manifestations, or independently of them. Sometimes the erythema takes the form of small papular spots, widely scattered over the face and body generally. More commonly it appears as erythema marginatum, or erythema circinatum, and is most marked in the neighbourhood of the joints. The various forms of erythema are most frequent when nodules are present, and like the last, perhaps afford some test of the intensity of the rheumatic affection. Erythema nodosum, although it appears independently of rheumatism, and runs a definite pyrexial course, is certainly more common in rheumatic children than in others. It is significant, moreover, of the connection between the two complaints that endocarditis occasionally ensues in cases of erythema nodosum where no other evidence of rheumatism can be elicited. Purpura rheumatica stands in the same relation to rheumatism as erythema nodosum, in that it runs a fairly definite course, is more common in rheumatic sufferers than in others, and is occasionally associated with endocarditis. Apart from purpura rheumatica other forms of purpura occur in rheumatism. Thus purpura may follow on intense erythema, or it may be primary in its manifestation, of rapid development, and attended by hæmaturia. Not very uncommonly a red rash, simulating the early stage of the scarlet fever exanthem, occurs in the febrile state of rheumatism, and may lead to some difficulty in diagnosis.

Endocarditis.—This is the most important feature of rheumatism, and the frequency with which it occurs is one of the most striking characteristics of the complaint in children. Donkin, in seventy cases of rheumatism, in children aged to fourteen, found heart disease in 87 per cent, and Church (8) found cardiac affections in 83 per cent in children under the age of ten. According to Dawson Williams (9), the heart is affected in three-fourths of all the cases of acute rheumatism under the age of fifteen. The younger the patient and the more definite the signs of rheumatism, the greater the tendency for the heart to suffer. In children under the age of seven, with rheumatism of such severity as to cause any definite arthritis, it is a rare exception for the heart to escape. The presence of nodules, too, few or many, almost infallibly points to heart implication. The valve most frequently affected is the mitral, the aortic suffering much less frequently, and generally at a later stage than the mitral. Endocarditis may be associated with a slight rise of temperature remaining up after the disappearance of the outward rheumatic symptoms. Usually, however, it gives rise to no pyrexia, and is only revealed by physical examination, a procedure that should never be neglected where rheumatism is even suspected in a child. A confident opinion, too, should not be expressed as to the freedom of the heart until a period of six months, or even a year, has elapsed after a severe attack of rheumatism, as the evidences of endocarditis may be very insidious and long in developing. The earliest indication of endocarditis is usually a blurring or prolongation of the first sound at the apex, and an accentuation of the second sound at the base. The blurring of the first sound frequently clears up under strict rest in bed, but in other cases is replaced by a definite systolic murmur. In heart cases of some standing, and usually where there has been more than one attack of rheumatism, it is not uncommon to find the systolic bruit at the apex preceded by a præsystolic and diastolic one. It is very uncommon, however, to find the long "purring" præsystolic murmur of adults in children under the age of puberty, this, perhaps, being due to the fact that the heart condition associated with it takes several years to develop.

Pericarditis.—This is less frequent than endocarditis, and indeed is usually accompanied by the latter. Pericarditis may, however, occur with positively no present or future evidence forthcoming of endocarditis. It usually occurs with the more definite signs of rheumatism, such as arthritis, and subcutaneous nodules are present in a large proportion of cases. In rare instances pericarditis is found where the other evidences of rheumatism have been so slight and evanescent as to escape notice. Such cases are extremely exceptional, and the number of them has been exaggerated by some writers, who have also strained the analogy between the pericardium and a joint in attempted explanations of them. The pyrexia is generally greater with pericarditis than with any other phase of rheumatism in children, and the temperature frequently ranges from 104° to 106°, or even higher. Pericarditis is usually present, too, in the unusual occurrence of death ensuing directly from the rheumatic attack. In all cases of pyrexia in children, with no direct obvious cause, the suspicion of pericarditis should be entertained, as the symptoms of pericarditis may precede or obscure all other manifestations of rheumatism. Rheumatic pericarditis very seldom leads to any great effusion into the sac. Cases of apparently great distension of the pericardium with effusion are generally ones of thickened membrane with dilated and hypertrophied hearts, and the criteria between the two conditions, such as the position of the apex beat and dulness to the right of the sternum in the fourth rib interspace, are unreliable when applied to actual practice.

Affections of the Cardiac Muscle.—In endocarditis and pericarditis the inflammation may spread to the contiguous layers of the cardiac substance by direct extension. In the slighter degrees of inflammation of the cardiac muscle resulting in this way, there are, probably, no physical signs traceable to it beyond those of the endocarditis or pericarditis responsible for it. Lees and Poynton have, however, shown by post-mortem evidence that a general and intense myositis may arise in the early and acute stages of rheumatism. Sturges (10), too, believed that a rheumatic carditis was a frequent occurrence in children, in cases where only the usual signs of endocarditis or pericarditis were present. A grave affection of the cardiac muscle should be suspected in the active stage of rheumatism when there is marked dyspnœa, a diffused and feeble apex beat, along with a frequent, feeble, and intermittent pulse, and there is no well-established valvular disease to otherwise account for such symptoms. In an exceedingly able article (Allchin's *Manual of Medicine*, vol. i.) Lees states that acute dilatation of the left ventricle is almost invariable in the rheumatism of children, the more marked cases being due to a definite myositis, and the slighter degrees of dilatation to a toxic action on the cardiac muscle. This acute dilatation, he insists, is in no sense a "complication"; it is a characteristic, and the most important part of the disease. But it may be said that the evidence he brings in support of this important proposition, increase in size of the deep cardiac dulness, is hardly convincing, as the limits of the deep cardiac dulness would probably vary in any one case with the powers of percussion of different observers, and even with those of the same observer from time to time. The changes in the cardiac muscle, found along with hypertrophy and dilatation, in cases of long-established valvular disease, have a direct origin in the valvular defects, and by no means imply any pre-existing inflammatory state of the muscle.

Chorea.—That there is a close association of chorea with rheumatism is not to be doubted. The exact relationship between the two complaints is still a vexed question, but the more it is looked into the more intimate the association is found to be. With a large number, indeed, of competent observers, chorea is regarded in every instance as simply and solely a manifestation of rheumatism. Not infrequently choreic symptoms, of slight or greater intensity, are found in children suffering from rheumatism. Very often, too, chorea will attack children shortly after the subsidence of a definite rheumatic attack. Again, children who have suffered from chorea, with no present or past evidences of rheumatism, are much more prone to future rheumatic attacks than others. It is not uncommon, moreover, to find endocarditis in choreic children with no history of joint pains or other rheumatic symptoms, and, but much more rarely, cases occur where chorea is associated with endocarditis and rheumatic nodules where other evidence of rheumatism is entirely wanting. These facts are incontrovertible and fully admitted, but they are totally insufficient to support the dogma that in every instance chorea is a direct manifestation of rheumatism. In the great majority of cases of chorea no evidence of rheumatism, either in the past or present, is obtainable. It is very common, too, for children to have repeated and frequent attacks of chorea, and in whom no endocarditis or other symptoms of rheumatism develops. The proportion of cases of chorea associated with rheumatism has been variously stated by different authorities—the variance in the figures being doubtlessly influenced by the fact of the observer being a believer or disbeliever in the pan-rheumatic origin of chorea. Thus Dr. Still (11), in 226 cases of chorea, found evidence of rheumatism in at least 55·7 per cent. Other good observers, with a full knowledge of how vague and fleeting the symptoms of rheumatism in the child may be, feel justified at placing the percentage of cases of chorea associated with rheumatism at as low a figure as 30 per cent. These last figures will have to be largely discounted, of course, by the fact that possibly many of the cases of chorea contracted rheumatism after passing out of observation, and that many of them, too, were possibly seen before the age at which some of the later evidences of endocarditis, such as mitral stenosis, had had time to develop. After making very liberal allowance for these considerations, however, it probably remains true that more than half the cases of chorea pass through life without exhibiting any of the more definite signs of rheumatism. If, then, chorea is merely a phase of rheumatism, in the majority of cases it stands alone in this last respect. In a disease like chorea, where the beginning and termination are often so ill-defined, and where there is so wide a variance in the severity and duration of the complaint, it is difficult to attempt any discrimination between one group of cases and another. On the whole, perhaps, it may be found that in the cases associated with definite rheumatism the onset is better marked, the acme as regards extent and violence of the movements sooner reached, and the duration shorter than in the cases where there is no evidence of rheumatism obtainable. The explanation of the frequent association of the two complaints is perhaps to be found in the neurotic predisposition which even the most ardent advocates of the infective origin of rheumatism are forced to admit.

DIAGNOSIS.—This is generally not difficult where arthritis is present, and rheumatism is by far the most frequent cause of arthritis in children. The subsidence of inflammation in one joint with its reappearance in another is extremely characteristic of rheumatism. The multiple arthritis secondary to exanthematous disease may lead to error if no reliable history be obtainable. But in such cases the arthritis is seldom so marked as it is in rheumatism when several joints are simultaneously affected. The symmetrical arthritis occurring in the subjects of inherited syphilis should not mislead, as the joint affection is too chronic and too little painful to own rheumatism as a probable cause, and in a large percentage of such cases, moreover, Hutchinsonian teeth and interstitial keratitis are present. Gonorrhœal arthritis is rare, but by no means unknown in children, and, in the absence of the characteristic discharge, it is only the persistence of the joint affection in spite of the administration of salicylates that may negative the diagnosis of rheumatism. In the absence of evidence of a source of infection, pyæmic arthritis may present great difficulties in the way of discrimination from rheumatism. The greater local inflammation and reddening of the skin, the longer persistence, and the nature of the temperature generally, eventually lead to the correct diagnosis. Acute arthritis sometimes occurs with the onset of anterior poliomyelitis. The age of the child, the restriction of the swelling usually to one joint, the paralysis of the affected limb, and the rapid onset of muscular wasting, are generally sufficient to avert mistakes. Infantile scurvy is sometimes mistaken for rheumatism, but the error should not occur where the age of the child, the other evidences of scurvy, and the fact that the swelling is primarily, at least, not in the joint, but over the shafts of the long bones, are taken into account. The swelling of the joints sometimes arising in association with syphilitic epiphysitis is hardly likely to be confounded with rheumatism if any care be exercised. Rheumatoid arthritis, a rare disease in children, may be mistaken for rheumatism in early acute stages. The resistance of the arthritis to the salicylates, the persistence of the complaint to certain joints and the freedom of others, the early muscular wasting, and the characteristic deformity about the joints, seldom permit the error to be one of a long duration. Apart from arthritis there is hardly anything characteristic about any of the other symptoms of rheumatism, and their nature is generally only settled by a history of arthritis in the past, or its subsequent appearance, or their association with fibrous nodules or endocarditis. It may be said, however, that growing pains of sufficient severity as to cause limping are very seldom due to any other cause than rheumatism.

PROGNOSIS.—Death is somewhat uncommon during the acute stages of the complaint, and exceeding rare in a first attack. In attacks other than the first, the prognosis should be founded on the extent any persisting heart affection has attained, rather than on any special feature of the active complaint. Pericarditis, however, is attended with especial dangers of its own, and is nearly always found in those dying during an acute attack. A combination of severe chorea with active rheumatism is of bad augury, as in such cases the temperature is apt to run up high, and recovery seldom ensues. Numerous or persistent nodules add much to the gravity of the attack. Large nodules usually foretell death at no distant date, and Cheadle (12) is right in the main when he states that the sight of them is the equivalent of that of the death warrant of the patient. Apart from these considerations, recovery is the rule whether the heart be left permanently damaged or not. If the prognosis, as regards recovery from acute attacks, be generally good, that as regards the recurrence of future attacks is correspondingly bad. Once rheumatism, always rheumatism, is not true, for even a young child may have a solitary attack of rheumatism and no more. But such cases are the exception, and usually a first rheumatic attack is usually the prelude to others in the near or distant future. Every succeeding attack adds to the gravity as regards the heart, either by originating endocarditis, or by adding its own quotum to a damage already sustained.

TREATMENT.—When any definite active rheumatism is present the child should be strictly confined to bed. He should be clothed in flannel, and rest between blankets instead of the ordinary linen sheets. Salicylate of soda should be given in doses of about three-quarters of a grain for each year of his age. This should at first be given every three hours in the day, and at night if awake, until the temperature returns to normal and all pains have disappeared. After this it should be continued three times a day for another fortnight at least. Should any toxic symptoms arise, such as delirium, vomiting, epistaxis, intestinal hæmorrhage, or albuminuria, then the quantity of the dose should be diminished, and the drug should only be entirely withheld in the case of absolute necessity. There is some advantage, probably, in giving some alkali, such as the bicarbonate of potash, along with the salicylate, in doses of two or three grains of the former to each grain of the latter. Painful joints should be swathed in flannel bandages, or better still in cotton wool covered with oil silk. Any obstinate arthritis is generally speedily benefited by small blisters in the neighbourhood of the joints, but young children are bad subjects, as a rule, for blistering. If there is much pain, then a single full dose of opium, appropriate to the age of the child, given at bed-time, is often extremely beneficial in procuring rest and sleep. After the salicylates have been stopped, the child should be put on a course of iron, such as four or five grain doses of the double citrate of iron and ammonia, whether marked anæmia be present or not. To this a corresponding quantity of citrate of potash is often a useful addition. As far as possible a supine position should be maintained, and if there be any suspicion of endocarditis, rigidly enforced. A change from the erect to the supine position means, on an average, ten beats less per minute, with a corresponding diminution in the labour of the heart. Not only this, moreover, but when endocarditis is present it means ten less flappings together of the inflamed valvular cusps, and a corresponding increase in the length of the diastole, the only time in the cardiac cycle when repair to its delicate structures is possible or probable. The course of salicylate should not be stopped on the advent of endocarditis. Any irregularity of pulse, or feeble cardiac action, is much more likely due to the disease than to the depressing effects of the drug, which have been much exaggerated. Such conditions are better met by the administration of strychnine, preferably by injection, rather than by the stoppage of the salicylate. Dr. Caton's statistics show such satisfactory results that his treatment deserves a trial in the early stages of endocarditis. This consists in giving appropriate doses of sodium iodide, and the repeated application of small blisters in the lines between the middle of the clavicles and the nipples on either side. Here again at first the salicylate should be given along with the iodide, as the baneful results of a relapse of the rheumatism are much more certain than that any benefit will be gained from the rest of the special treatment. In the early stages of pericarditis two or three leeches should be applied over the heart, or recourse may be had to the ice-bag so warmly advocated by Lees. Blisters, too, are probably useful, but their use interferes with a complete and satisfactory daily examination of the heart. When there is pain or distress no drug is so useful as opium, and this can also be given at first with the salicylate. Alcohol is very seldom required in any of the active phases of rheumatism in children. A child should be kept in bed for at least a month after the subsidence of an attack of marked rheumatism. This, however, is generally difficult of attainment, as the child, perhaps feeling quite well, resents the confinement to bed as irksome, and only too often the parents totally fail to appreciate the gravity of the complaint when once the severe symptoms have disappeared.

The child who has once had rheumatism should be clothed in flannel or woollen next to the skin, and the clothing is of more importance in the summer even than in the winter time. He should be restricted from the more violent games, such as running or football, not only because the fatigue they cause predisposes to rheumatism, but also because the fact of having had rheumatism should render his heart an object of suspicion, although he may present no evidence of valvular defect. If possible, he should not reside in low, damp places, such as the Fen country in England, where there is no doubt rheumatism is unduly prevalent. Apart from such notoriously unsuitable places, however, care and protection from fatigue and damp are more important than place of residence. Numerous places bear a reputation as being "anti-rheumatic" on evidence that will not bear investigation; whilst residence by the sea seems beneficial to some children, to others it is apparently detrimental. In fact, when the choice is restricted to these islands, a suitable place of residence is more or less a matter of chance. The prevalent belief that too much butcher meat is harmful for rheumatic children rests on some slight foundation, and it may be well to put the child on a diet where a slight deficiency in it is replaced by an extra quantity of milk, fish, vegetables, or other food. The practice, too, of giving the juice of a fresh lemon daily to a rheumatic child, in the shape of lemonade, can seldom do any harm, and it may possibly do good by ensuring the continuance of a mild alkaline course in a pleasant and acceptable form.

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Rheumatoid Arthritis

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SYNONYMS:—Arthritis deformans, Polyarthritis chronica, Osteo-arthritis, Rheumatic gout, Mechanical or Traumatic arthritis, Arthritis chronica villosa.

Few diseases so common as rheumatoid arthritis, and of equal importance, are regarded by the profession with so little unanimity. This form of joint affection is known to be of great antiquity; the Museum of the Royal College of Surgeons possesses bones showing characteristic changes which date back to 1300 B.C. It has received the attention of generations of able workers, but even now wide diversity of opinion exists among observers of repute as to its pathology and true place in medicine. It seems possible that conditions widely different in origin, in clinical manifestations, and in results, have been grouped together as rheumatoid arthritis, leading to the confusion apparent in writings on the subject.

An attempt will be made in these pages to describe the disease as it occurs in adults, and in certain varieties which are marked off from each other with some clearness. It is perhaps doubtful whether these groups will ultimately be placed together under one name, but for the present, tradition and convenience require that they should be considered side by side.

Cases presenting themselves for observation in adults fall into the following main clinical groups:—

1. Polyarticular rheumatoid arthritis: (*a*) subacute and chronic; (*b*) Acute.
2. Localised or senile rheumatoid arthritis.

1. POLYARTICULAR RHEUMATOID ARTHRITIS

(*a*) *Subacute and Chronic*

Etiology.—Age.—This form occurs at any age from childhood to late adult life. The age most prone to attack appears to be that between thirty-five and fifty, the period of commencing tissue degeneration. Cases occurring much earlier are common, and women are frequently attacked during the time of greatest reproductive activity. The records of the New Hospital for Women furnish repeated examples of this fact. A certain number of cases appear about puberty. On the whole, the earlier the time of attack the more severe and rapidly progressive is the course of the illness, but there are exceptions to this general truth. Some of the early cases improve strikingly under treatment, and the disease may even become arrested if it has been recognised early and dealt with at once.

Hereditary influence does not appear to be strongly shown in the history of this disease. Garrod considers that heredity has an unimportant bearing on its production, and is decidedly less marked in this affection than in gout ; it is probably not to be traced with any frequency even in the rheumatoid arthritis of children. It is not very rare to find several female members of a family suffering more or less severely from rheumatoid arthritis, and a history can sometimes be obtained, especially in private practice, of a joint affection which sounds like rheumatoid arthritis in relatives in a previous generation. It is not unknown for several male members of one family to suffer from early and severe forms, but this is rare. Bannatyne analyses 293 cases, and finds a history of clear inheritance in fifteen only. Statistics as to heredity, compiled from the statements of patients respecting the joint affections of their relatives, are open to fallacies so obvious as to greatly diminish their value.

As regards *sex*, there is undoubtedly a great and special liability among women to suffer. Badt gives a recent analysis of fifty-three cases observed by him. Of these 6 per cent were males, 94 per cent were females. In 80 per cent of the female cases the illness began at the climacteric. The influence of pelvic disease and of the menopause has been dwelt upon by many writers, and statistics show that these conditions are of great importance. At the climacteric the general health of women is lowered, and they are then liable to suffer from diseases of the reproductive system. Of such diseases probably those most potent in the production of rheumatoid arthritis are such as are associated with exhausting losses from the uterus, especially hæmorrhages from any cause, and, to a less degree, copious purulent or muco-purulent discharges. At the New Hospital for Women the occurrence of rheumatoid arthritis, more or less severe, in association with menorrhagia due to fibroid tumours of the uterus has been repeatedly observed. Such an association has been noted also by Ord. Other less definite conditions, such as uterine displacements, or ovarian neuralgia, have been thought to bear some causative relation to the disease, but it is difficult to trace the evidence on which this opinion is based. Chronic ovarian pain seems a possible influence, and in one case had been a source of great suffering in an unmarried woman of thirty-two, who developed severe rheumatoid arthritis.

It has been suggested that the special liability of women at the climacteric may be due to a failure on the part of the ovary at that time to exercise its normal influence on general nutrition, and Badt suggests the use of ovarian extract. The idea belongs at present to the region of hypothesis, but deserves further investigation. There does not appear to be a special danger of the onset of the disease after the removal of the ovaries surgically. This point has been under observation at the New Hospital for Women, and so far the evidence is negative.

Garrod pointed out that rheumatoid arthritis occurs early and in severe forms in association with rapid child-bearing and over-lactation, and other observers have amply confirmed this statement. It is probable that any cause whatever which tends to lower the general health and to produce marked debility and failure of nutrition may predispose to the disease. In women diseases of the pelvic organs form so considerable a proportion of the causes of ill-health, that it is to be expected that these diseases should take a prominent place in the history of an illness liable to attack the debilitated from any cause.

Prolonged mental strain, long anxiety, and worry are very frequently present in the history of these cases, in association with other debilitating conditions. In some cases the history of mental worry or anxiety seems the most prominent fact in the history, and stands out alone, or as the chief factor which can be made out.

As a rule, the depressing mental conditions have been of long standing, going on for months or even years, but there is some evidence that a severe shock may be followed quickly by joint changes. The writer has notes of a case in a woman of thirty-five, in whom rheumatoid arthritis in a severe form followed immediately on the shock occasioned by the sudden death of her twin children. Cases of a like nature have been recorded by others.

Climate probably has some influence on the production of this complaint, as it undoubtedly has upon its course. Charcot considered damp cold to be one of the most potent factors. Bannatyne states that the disease is more common in the humid air of Ireland than in England; Adams that it is prevalent in Holland; and Stewart that it is very rare in the dry climate of Canada. In a certain number of cases the disease is referred to a definite exposure to cold or damp, or both, such as sleeping in a damp bed, or getting wet and sitting in damp clothes. The combination of damp, cold, a low elevation, and low average of bright sunshine appears to be favourable to its development—in other words, the climate least likely to lead to good general health and a high vitality of the tissues.

The influence of *traumatic injury* to joints has been variously estimated by writers. It is generally accepted as true that in the mon-articular form previous injury may determine the localisation of the affection, even when the injury has occurred long before the onset of the joint changes. It is also true that in cases of moderate generalised rheumatoid arthritis an injury may greatly increase the activity of the disease in the injured joint, which may quickly become completely crippled, although the activity of the joint affection generally is not increased.

Cases are recorded where injury to one joint was apparently followed by generalised rheumatoid arthritis. The evidence in those cases available for reference is not absolutely convincing, and in some the length of time which had elapsed between the injury and the onset of the generalised disease was so great that the influence of the injury appears somewhat doubtful.

There is some evidence that joints which have previously been attacked by the inflammatory processes of acute rheumatism are prone to be affected later by rheumatoid arthritis. Luff states that acute rheumatism is an undoubted predisposing cause of this disease. Modern views as to the pathology of these affections tend to minimise rather than to accentuate the points of difference between them. If acute rheumatism, and certain forms at least of rheumatoid arthritis, have a bacterial origin, as some believe, it is possible that the tissues of a joint already damaged by one such infection may readily become a nidus in which other organisms can flourish. It is certain that the changes characteristic of chronic rheumatoid arthritis may supervene in other chronically inflamed joints, *i.e.* those of gout or of gonorrhœa.

A low *diet*, deficient in nutritive elements, may be an important element in the causation of rheumatoid arthritis. Alcohol has not the same directly deleterious effect on these patients as on the sufferers from gout.

Clinical Characters of Subacute and Chronic Polyarticular Rheumatoid Arthritis.—The onset is insidious and difficult to date from the accounts given by patients.

Premonitory symptoms have been described by some writers, such as abnormal sensations in the extremities, tingling, pins and needles, and numbness, especially on waking from sleep. These sensations are frequently complained of early, but examination shows that some joints are already affected, and pain and enlargement of joints are the earliest distinctive symptoms. The joints most liable to attack are those of the hands, and, broadly speaking, the disease assumes a symmetrical arrangement, attacking corresponding joints on the two sides, and tending to advance from the extremities towards the trunk. The number of joints affected varies greatly, and there appears to be a process of selection which may be different in different cases, but is usually the same on the two sides of the body. The joints commonly attacked are the interphalangeal joints of the hands, or some of them, the metacarpo-phalangeal joints, the wrist, elbow, and shoulder. In the lower extremities the knee is very frequently attacked, also the ankle, the small joints of the foot, and the hip. The temporo-maxillary joint is frequently affected, a fact which is valuable in diagnosis, and serves to distinguish this from other forms of arthritis, except that which is the result of gonorrhœal infection. Involvement of the joints of the vertebræ occurs, especially of the occipito-atloid joint, resulting in stiffness or definite limitation of nodding or rotatory movements of the head. The pain due to involvement of the spine may be very severe.

Although marked symmetry of arrangement is the rule, and is a characteristic feature of the disease, it is by no means invariable. The joints on one side of the body may show evidence of advanced changes, while those on the other side are only slightly affected, and there are also exceptions to the rule that the disease tends to advance in order from periphery to trunk. Joints may be picked out for attack without reference to anatomical sequence (Fig. 1). Symmetry is more apparent in the earlier and more rapidly progressive cases. In those less active the disease shows a tendency to remain localised in a few joints.

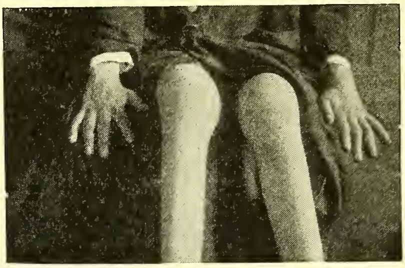

Fig. 1.

The changes once begun have no spontaneous tendency to recover, and the joint becomes the seat of a gradually progressive disorganisation, unless the disease is arrested by treatment.

The actual condition of the joint varies. Clinically, two main varieties of joint change are noticeable.

(*a*) The joint assumes the shape of a more or less symmetrical truncated spindle, it is swelled, its normal contour is obscured, and its bony landmarks are difficult to make out. The impression received on examination is that the soft parts, both within and without the joints, are uniformly swelled and thickened. This form is well seen in the finger-joints, and is shown in Fig. 2. The joint is tender to touch, sometimes even hot, and movement is painful and limited. The terminal inter-phalangeal joints frequently escape attack. Not rarely the joint contains fluid, and definite fluctuation is present. In other cases no fluid can be made out, but the joint has a characteristic doughy, semi-elastic feel. The metacarpo-phalangeal joints suffer frequently, especially those of the first and second

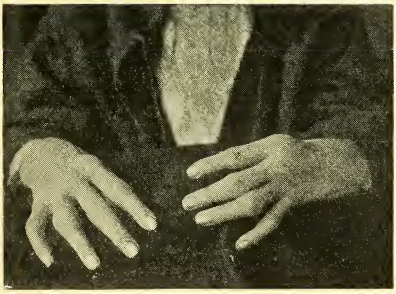

Fig. 2.

finger. That of the little finger is usually less affected. No bony out-growths may be present, no lipping, nor any gross bony changes. The condition is suggestive of a chronic inflammatory over-growth of the soft parts of the joint, especially of the synovial membrane. Schüller proposes calling this form chronic villous arthritis (arthritis chronica villosa).

(*b*) The other type of joint change presents a striking contrast to that described above. The joint is enlarged, but the enlargement is irregular and often nodular. The bony landmarks are more, rather than less, prominent, and there is obvious bony enlargement, lipping of the articular surface, and definite osseous out-growths can often be made out. Tenderness on manipulation is not usually very marked, though some areas of the joint may be decidedly tender on deep pressure. Movement is limited and painful, and may be attended with marked grating, due either to actual contact of bony surfaces, or more often, probably, to creaking of thickened periarticular tissues. The joint may become completely immobile and apparently ankylosed, or the bony out-growths may be so situated as mechanically to lock the joint. There is usually no excess of fluid in these joints. This form also can be well studied in the hand, especially in the metacarpo-phalangeal or carpo-metacarpal joints of the thumb. The terminal phalanges may show Heberden's nodes at their bases. This type is shown in Fig. 3.

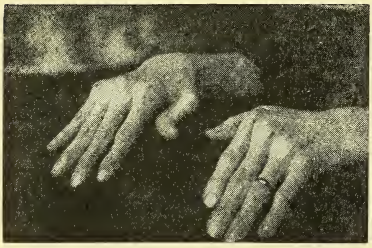

Fig. 3.

Speaking generally, the first group represents the more acute form of the disease and occurs in younger patients, the second the more chronic form.

In some late cases the joint shows a combination of bony enlargement or nodosities, with increased thickening of soft parts and fluid effusion, but it is certain that joints may exhibit typically the bony changes last described without having passed through a stage of general spindle-like swelling or fluid effusion. The two varieties have clinically well-defined characters which merit separate description, and it seems certain that spindle-shaped swelling is not merely the early stage of an arthritis which passes inevitably into a condition of bony out-growth and enlargement.

(*c*) In a third condition occasionally seen, some joints of the fingers, especially the terminal inter-phalangeal joints, seem actually smaller than usual, and their movements more than normally free. They are painless, and look as if there had been some atrophy of all the parts concerned—bones and soft parts alike. This condition is present in association with spindle-shaped enlargement of joints rather than in the more chronic type with bony out-growth.

The anatomical changes in the joints are invariably associated with more or less *atrophy of muscles* of the limb; sometimes the atrophy is extreme, and adds greatly to the general deformity. The extensors of the joints suffer usually more than the flexors. In the hand the interossei muscles suffer, epecially the dorsal interossei. The thenar and hypothenar eminences do not escape, and the general wasting of muscles of the limb may be so decided as to simulate the changes in progressive muscular atrophy.

The reaction of degeneration is usually absent. The wasting of muscles bears no necessary proportion to the degree of involvement of the joint, and it may be very marked where the joint changes are slight or moderate. Fig. 4 shows a case with extreme wasting of the muscles of the leg. The tendon reflexes in the affected limbs are frequently, but not invariably increased.

The *deformities* resulting from the joint and muscle changes have been studied and described by many writers. In the hands a common and early change is ulnar deflection of the fingers at the metacarpo-phalangeal joints. At first the deflection is slight and easily reduced, later it may become extreme, and only partially or not at all reducible. The other deformities of the hand depend on flexion and extension of the phalanges on each other, or on the metacarpal bones. The knee joint in advanced cases is almost invariably flexed. The ankle joint is frequently fixed, the foot abducted, and the great toe deflected to the outer side. The temporo-maxillary joint may be ankylosed, and the patient unable to masticate, and the head may be fixed, either in a natural position or in a position of flexion or rotation, from changes in the cervical spine.

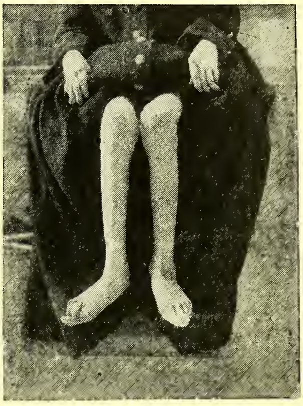

Fig. 4.

The causes of the deformities are briefly either—

(*a*) Ankylosis or partial ankylosis of joints, or changes in the form of the articular surfaces.

(*b*) Atrophy of certain groups of muscles and increased tonicity or spasm of others, leading to disturbance of normal relations of muscular groups to one another, and in extreme cases causing actual dislocation of bones, partial or complete.

(*c*) Changes in the ligaments and tendons about the joint, commonly in the direction of increased laxity or destruction.

(*d*) The effect of gravity and habitual posture.

Most of the deformities of rheumatoid arthritis are not peculiar to it, but may be present also in other chronic affections of the joints, such as gout, and in various diseases of the central nervous system where the nutrition of muscles and joints is affected.

Polyarticular rheumatoid arthritis does not consist only in the joint changes and their results, but presents other clinical features of interest.

The *temperature* is usually normal, but even in the less acute cases may show irregular evening rises of one or two degrees, with occasional more decided fever. Such pyrexial periods may alternate with times when no rise is noted, and do not appear to be connected necessarily with obvious extension of the disease.

The *pulse* varies. It has been pointed out by Spender, Dyce Duckworth, and others, that a rapid pulse may be present, and the former author attaches great importance to the fact, and considers it to be of very frequent occurrence and of diagnostic value. He speaks of a pulse-rate of 110, 115, 120, and even 140 in apyrexial cases, and in association with coldness of the surface.

The opinion of clinical observers generally will probably be that such decided persistent rapidity of the pulse as this is not the rule, and it is an undoubted fact that, even in cases showing slight evening fever, the pulse-rate may not rise above 90 for weeks together. In some cases there is irregularity of the pulse, and it tends to become temporarily quickened by slight causes.

Anæmia is present in most cases to a greater or less extent. It is usually moderate in degree, persistent, and not easily amenable to treatment. In some cases the anæmia is very striking. The hæmoglobin value of the individual red corpuscle is reduced, and there may be some relative increase of white cells. The presence of anæmia is considered by some writers as evidence of bacterial toxæmia. Bouchard gives 91 cases of anæmia in 1000, a proportion smaller than experience in this country would suggest.

The *lymphatic glands*, especially those of the axilla and groin, may be enlarged in certain cases in adults. Bannatyne states that he has found a chain running up from affected joints. He has never found an enlarged spleen. Still and others mention enlargement of glands in children, especially those of the axilla and groin. In children the spleen is enlarged in one, at least, of the conditions called rheumatoid arthritis.

The state of the patient as regards *pain* varies greatly in different cases, and at different times in the same case. Pain is often severe and persistent, worse at night, and aggravated by movement and by changes in the weather. In other cases the patient complains chiefly of great stiffness of joints, especially after sleep or resting. Rarely true neuralgia of a severe type is present, and in those cases the bouts of pain have, in the writer's experience, tended to occur in the night after a first sleep. In Buchard's analysis of 1000 cases neuralgia occurred in 30.

Stiffness of joints may be an early sign, and frequently appears before pain is complained of. It should always suggest the possibility of rheumatoid arthritis.

Evidence of *trophic* or *vaso-motor* changes of the skin is common. The skin of the hands and feet may be cold, blue, and clammy, and a combination of cold hands and feet, with profuse sweating of the palms and soles, is striking and characteristic. Sweating, either general or confined to some one area, such as the hands, feet, upper lip, etc., is common, and patients sometimes complain of exhausting nocturnal sweats. The skin may show areas of definite atrophy, especially near affected joints, such as "glossy skin." There may be patches of congestion and distressing sensations of burning or pricking. Spender and others have laid stress on pigmentation of the skin. It is present in a large number of cases, but whether there is any form of pigmentation of the skin peculiar to rheumatoid arthritis, either in tint or distribution, is perhaps doubtful. Pigmentation occurs in connection with many chronic diseases, especially those associated with failure of nutrition, but also in apparently healthy subjects. It occurs under such varying pathological conditions that it can hardly be considered as diagnostic, but should, perhaps, be regarded as an incident in numerous conditions of ill-health, of which rheumatoid arthritis is a notable example. Pigmentation occurs as—

(*a*) A general darkening of the complexion, most marked usually on exposed parts.

(*b*) As large patches of pigmentation in various parts, of irregular shape, uniform in colour, and with well-defined edges.

(*c*) As more or less widely spread small patches with a general appearance like freckling, or splashes of paint, not usually most marked on exposed parts, but on the trunk and limbs, especially, sometimes, on parts exposed to pressure, such as the waist, garter areas, etc. In this form there may be decided symmetry in the arrangement of the patches. The tint varies from pale honey shades to dark brown or black, and is influenced to some extent by the natural complexion of the patient.

Bannatyne mentions the occurrence of subcutaneous hæmorrhagic effusion, and also under the nails.

The nails are often dull, brittle, and show longitudinal striations.

Œdema is occasionally present either in patches near joints or of dependent parts.

Neuritis may occur leading to severe pain along a nerve trunk, and followed by rapid wasting of the muscles supplied by it, with loss of faradic excitability. When, in this disease, loss of faradic excitability is present, it is usually restricted to one or more muscles, and is probably the result of secondary neuritis.

Garrod and others have thought *psoriasis* was apt to occur with more than average frequency in association with rheumatoid rheumatism.

In children slight *exophthalmos* has been noted.

Bouchard finds *dilatation of the stomach* in no fewer than 273 cases in 1000.

The condition of the *heart* is a subject about which a good deal of diversity of opinion exists. Recent work has revived interest in this point, but a definite conclusion is difficult to arrive at.

Garrod considered the absence of cardiac inflammation as one of the most important diagnostic features of rheumatoid arthritis, and said he had never traced the occurrence of pericarditis or endocarditis in this disease. Charcot believes that both may occur, and brings post-mortem evidence to prove the existence of endocarditis. In one, at least, of the diseases called rheumatoid arthritis in children there appears to be a remarkable tendency to inflammation of the pericardium, and post-mortem examination in these cases shows adherent pericardium with striking frequency. In the account of a post-mortem examination on a patient aged thirty-seven recently published (42), it is stated that the surfaces of the pericardium were adherent.

In acute cases there may be clinical evidence of endocarditis or pericarditis. Bannatyne publishes two cases (*Brit. Med. Jour.* 1898) in which these complications were a marked feature. In one case observed by the writer there was pericardial effusion. In the larger number of cases no clinical signs of heart complications are present, but in some there are well-marked cardiac murmurs. These have hitherto been ascribed to the results of previous attacks of true rheumatism. In some cases, no doubt, this explanation is the correct one, in others no evidence supports it. It is possible that when the significance of acute attacks is more generally appreciated, an illness which formerly would have been ascribed to acute rheumatism will be regarded as acute rheumatoid arthritis.

It is worthy of note that in enumerating the diseases associated with ‘chronic articular rheumatism," in 1000 cases Bouchard records no fewer than 60 cases of aortic disease, and 91 of hypertrophy of the heart. These figures suggest the need of further observation of heart conditions in this disease.

The urine usually presents no important changes from the normal. Angel Money found excess of urea and uric acid, and occasionally glycosuria. Drackmann and Böcker both found diminution of phosphates. Schüller constantly finds a diminution of calcium salts and earthy phosphates, a low specific gravity, and a reaction either faintly acid or neutral in the variety he calls arthritis deformans, *i.e.* where bones rather than soft parts are chiefly affected. Van Noorder, Rumpff, and others have noted similar changes, and Schüller considers them characteristic. Bain (*Edin. Med. Journal*, 1900) analysed the urine in one case only, and found diminished excretion of uric acid.

Occasional accompaniments of rheumatoid arthritis, which have received a good deal of study, and which frequently occur in the same subject, are—

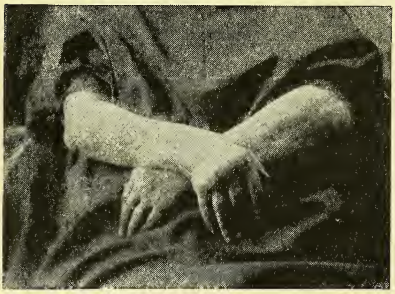

Fig. 5.

(*a*) A chronic bursitis with thickening of the walls of the bursa, and some fluid effusion. This is well seen in the bursa over the olecranon, and may be present near joints in both the upper and lower extremities.

(*b*) Subcutaneous fibrous nodules, resembling in some respects the nodules which occur in true rheumatism. Fig. 5 shows both these conditions in a marked degree. The bursa over the olecranon on both sides formed a visible tumour, and its walls were greatly thickened. Several hard bodies could be felt within its cavity. The swellings were painless, and had always been so.

The smaller swellings were due to subcutaneous fibrous nodules, oval, flattened, painless, and freely movable.

These nodules differ from those characteristic of true rheumatism in certain particulars.

1. They appear in late life.
2. They persist longer than is usual with those of acute rheumatism. In the patient shown in Fig. 5 the nodules are known to have remained unaltered for three years.
3. The history of acute rheumatism is not usually obtained, nor is there any evidence pointing to its presence, or to the presence of active and progressive cardiac complications.

While in hospital the patient referred to above developed a new nodule on the right olecranon. It was at first the size of a hemp seed, decidedly tender on pressure, and grew very slowly. It felt precisely like a true rheumatic nodule. In this case the nodules were confined to the arms. There was no history of acute rheumatism.

Ganglion-like distension of the sheaths of the tendons of the muscles of the hands have been described.

The *course* varies within very wide limits. The disease may progress with appalling rapidity, one joint after another being quickly involved, until the patient becomes a helpless cripple, unable to walk, stand, or feed himself, and with many joints fixed and useless. Such severe cases occur usually in younger patients.

The affection may be much less acute than this, and for years after the nature of the illness is recognisable the patient is able to live an ordinary life, complaining only of pain, stiffness, and some disfigurement of joints. The activity of the affection varies at different times, and conditions affecting the general health adversely also make the joints worse.

In some cases in elderly subjects no complaint of pain is made, though the hands show to a typical degree the bony changes which have been described, and are markedly deformed. There is no evidence that such hands have ever passed through a stage when there was spindle-shaped swelling of the joints of the fingers or pain. The patients have usually laboured hard, and the hand presents the character which Lane has described as mechanical or traumatic arthritis. Washerwomen exhibit this condition typically.

(*b*) *Acute Polyarticular Rheumatoid Arthritis*

The occurrence of an acute form has long been known and its clinical characters described. Later work has emphasised the importance of this variety of the disease, and it has received careful study, especially as regards etiology, since the possible bacterial origin of rheumatoid arthritis has engaged the attention of authors.

Although no hard-and-fast line can be drawn between this form and the more acute cases of the so-called chronic variety, certain features are worthy of attention.

As regards etiology.

Age.—It occurs before middle life, chiefly in children and in young adults, but is not unknown later. The case shown in Fig 1. began at thirty-nine.

It is a notable fact that some, at least, of the cases occur in definite association with septic infection. Suppurative tonsillitis, otitis media, suppuration in bone, behind the plate of false teeth, and gonorrhœa, have been present in the history of these cases. The influence of pyorrhœa, alveolaris, and other septic conditions of the mouth in the production of disease, has been insisted on by Hunter and others, and it is possible that oral sepsis may not be without importance in this connection. In one acute case in a girl of twenty recently under the writer's observation the gums and buccal mucous membrane were in a highly septic condition.

The *clinical characters* of the acute cases are as follows:—

The onset is sudden, or at least definite—the patient can give a precise account of the beginning of the illness.

There is decided fever, the temperature rising to 101°, 102°, or even higher each night. The affected joints are painful, tender, and swelled—there is effusion of fluid into them.

So far the resemblance to acute rheumatism is close, but the following points will help to distinguish this affection.

The joints affected are usually the smaller joints, and there is not the same tendency to migration which is characteristic of the arthritis of true rheumatism. The joints attacked do not return to the normal, but further changes develop in them, and the spindle-shaped swelling of the finger joints already described quickly appears. The following case is a characteristic example of this affection:—

Woman. Aged twenty-six. Married. One child.

Previous health good, but for six months before present illness the patient had repeated attacks of tonsillitis with "gatherings" on the tonsil. She was suddenly attacked with joint pains, the finger joints and wrists were affected, and later the shoulder and knee.

When admitted to hospital the proximal inter-phalangeal joints of the fingers were swelled, painful, and contained fluid. Temp. 101°; pulse 90.

There was a soft systolic bruit to be heard at the apex.

The patient was treated by salicylates with little benefit, and the hands quickly showed characteristic changes, such as are described above, and illustrated in Fig. 1.

She left the hospital after six weeks' stay with these changes distinctly present in the hands and wrists, with no evening temperature, and with the cardiac bruit still audible; pulse 80.

There was no history of a previous attack of acute rheumatism in this case.

2. Localised, Senile, or Monarticular Arthritis

In this variety of joint affection there are clinical points which mark it off in a striking way from the other varieties which have been described. So decided are the differences, indeed, that they are more evident than the points of likeness.

The disease is essentially a local affection, has little tendency to symmetrical arrangement, and none to become generalised. It attacks those in late middle life or in old age. There is no pyrexia or evidence of constitutional disturbance. It frequently follows upon injury, and is more common in men than in women. The larger joints near the trunk, the hip, and the shoulder especially, are most apt to suffer, a fact which contrasts sharply with the localisation of the generalised polyarticular form, in which the small peripheral joints, more particularly those of the hands, are attacked with a frequency so great as to constitute a diagnostic feature. The affection is usually localised in one joint, but occasionally the corresponding joint on the opposite side may be affected in a lesser degree.

When the hip is the joint affected there is pain, stiffness, and limitation of movement. The patient walks lame, and finds it difficult or impossible to cross one leg over the other. The amount of actual change in the joint detected by examination varies. In muscular or fat subjects the hand may detect little, but limitation of movements and possibly some deep-seated grating, or shortening and eversion of the limb may be made out. In thin subjects definite changes in the anatomical outline of the joint can usually be felt, with irregularities due to bony changes, the "condyloid crests" of Hutchinson.

In the neighbourhood of such joints, as also in connection with Charcot's disease, the cysts described by Morant Baker may be present.

In the case of the shoulder, where the joint is more within reach of examination, changes in the articular surfaces can often be readily made out.

It is not certain whether the enlargement of the normal prominences on both sides of the terminal phalanges of the fingers on their dorsal surface, called Heberden's nodes, should be described in this place. If they are to be included at all among the manifestations of rheumatoid arthritis, it seems suitable that they should rank with the most chronic forms included under this group. They occur alone, or in association with the monarticular or very chronic generalised forms, rather with the more acute disease, and may be conspicuously absent when the other finger joints show decided spindle-shaped swelling. There is seldom much pain, but the joint may be stiff and the disfigurement considerable. Deflexion of the terminal phalanx to the radial side is a common deformity. Great difference of opinion has existed among authors as to the pathology of these little growths, which have been variously regarded as of a gouty nature, or as due to rheumatoid arthritis. They certainly occur in the chronic forms of rheumatoid arthritis, and have been found also where there is a gouty history. Garrod states that he has never seen them in true gout, and they have little in common with any other known result of gout.

Still has twice seen similar nodosities in children with congenital syphilis.

It is noteworthy that Bouchard quotes the diseases associated with Heberden's nodes in 1000 cases, and rheumatoid arthritis does not occur in this list.

Much light is thrown upon the production of permanent changes in the joints of the elderly by the well-known writings of Arbuthnot Lane. He does not accept the view that the changes are due to disease, but believes them to be "produced mechanically and in obedience to simple general laws." It is difficult to trace to this cause the acute forms of rheumatoid arthritis—those associated with fever, with effusion into joints, and with the characteristic changes which are included in Schüller's definition of arthritis chronica villosa. It is possible that a further classification will be adopted, and a distinction as regards pathology will be drawn between such cases as are included in Lane's description and the more acute generalised forms. Changes similar to those described by Lane are found in the lower animals, notably in old horses which have laboured heavily. Whether the acute form occurs in the lower animals is doubtful, and Bannatyne suggests that the failure of inoculation experiments may be due to the fact that the animals subjected to experiment were immune, and that rheumatoid arthritis as an acute affection does not occur in them.

Morbid Anatomy.—The changes in the interior of a joint affected by rheumatoid arthritis are as follows :—

(*a*) The articular cartilage is affected early—some think it is the primary change—the surface loses its polish, becomes dull and velvety, owing to splitting of the matrix into fine vertical fibrillæ, and destruction and disappearance of cartilage cells. The change is most marked towards the centre of the cartilage, and may extend and deepen until in the central part its whole thickness is destroyed, and the head of the bone beneath laid bare. In addition to this disintegration a process of irregular formation takes place at the periphery of the articular cartilage, leading to the lipping or nodulation common in later stages. In these outgrowths bone may afterwards be deposited and osteophytes formed. This over-growth is considered by Cornil and Ranvier to be due to the fact that the outer edge of the cartilage is overlapped by folds of synovial membrane, which prevent the escape of cartilage cells into the cavity of the joint. Probably, also, the mode in which pressure is transmitted through the joint determines the site of greatest destruction of cartilage—the cartilage being destroyed chiefly "at the point of greatest stress." In old-standing cases the articular cartilages may be absorbed, and even the inter-articular cartilages, in such joints as the knee, wrist, or jaw (40).

(*b*) The bone beneath shows a thin layer of greatly increased density, it is smooth, polished, and ivory-like (eburnated). Its surface may be more or less deeply furrowed by the steady friction of prominences on the opposite bone. The lipping and the position of osteophytes may more or less completely destroy the mobility of the joint, or alter its mechanism so as to render possible movements which could not be performed by the normal joint. The osteophytes themselves may be worn away or eburnated.

The joint may be fixed by true bony ankylosis, which occurs in the spinal column. In affected joints where the cartilage is destroyed the articular surfaces have been described as united by bridges of cancellous bone easily broken down by slight pressure (42). Fibrous ankylosis of joints is not uncommon, but true bony ankylosis in the joints of the limbs is not the rule. It is only likely to occur in bed-ridden patients whose joints are at rest and much disorganised.

If the head of the bone is sawn through it is seen to be of an unusually spongy consistence, and to contain a large proportion of oily matter, as if from a species of fatty degeneration (40).

The condition of the synovial membrane is variously described. In a joint showing the above changes both the synovial membrane and the fibrous capsule of the joint will be greatly thickened, its fringes hypertrophied, and many will be seen to have undergone fatty changes, or to contain cartilaginous or osseous masses. These may become detached and form loose bodies in the joint. The bursæ near joints may show marked thickening of their capsules, and form decided swellings, and may contain hard bodies in their cavities. This is common in the bursa over the olecranon (Fig. 4). Bursæ may entirely disappear. In two shoulder joints from the same subject lately examined by the writer the subacromial bursæ had entirely disappeared, and the head of the humerus articulated directly with the upper part of the glenoid fossa and with the acromion. The ligaments of the joint may become thickened or stretched and elongated. Tendons entering into the structure of the joint may be entirely or partially destroyed, such as the ligamentum teres of the hip, or the biceps tendon of the shoulder (40). The muscles about joints may find new attachments to capsule or ligaments rather than to bony points. This was the case in the shoulder joints already mentioned.[1]

Suppuration is of extreme rarity, though a few cases are on record (75), and effusion of blood into the joint is referred to by Goodhart.

The above description can hardly be considered to apply with any closeness to a large number of cases of acute onset and rapid course, which, clinically, do not present the features which are detailed above. Bony out-growth and deformity are absent in such joints, and their absence is evident not only to the fingers of the examiner, but also by the more convincing test supplied by the X-rays. A skiagraph from such a case is described and figured by Bannatyne.

A description of the joint tissues removed by operation has been given in detail chiefly by Continental writers, and it throws an important light on certain features of the disease. Schüller of Berlin has described the appearances in joints operated on by himself (99). He proposes to call a group of cases which he believes to have distinctive features "Arthritis chronica villosa," and reserves for chronic cases with changes in the bone and cartilage the name Arthritis deformans.

The essential feature in the former is chronic inflammatory over-growth of the synovial membrane, with the formation of fringes and tufts much larger and more massive than in normal joints, or in those the seat of other inflammatory processes.

In freshly-opened joints the synovial membrane shows red, swollen, and highly vascular. He has never found in these cases the changes of the cartilage characteristic of arthritis deformans. In this form, and in this form only, he found a peculiar bacillus in the villi, to be described later. It is interesting to remember in this relation Bannatyne's statement in 1898, that his bacillus was found only in the acute polyarticular cases with soft synovial enlargement, and not in the chronic cases with out-growth of bone and lipping.

Schüller considers that the change in the contour of the joint in the group he calls polyarthritis chronica villosa is due entirely to the chronic inflammatory thickening and extensions of the synovial membrane caused by the invasion of a peculiar bacillus, and not at all to bony changes. The chief changes in the joint in the group he calls arthritis deformans is, on the other hand, in the articular cartilage, and depends on prolific over-growth of cartilage cells, swelling of cell spaces, and splitting up and wearing away of the cartilage at friction and pressure points, with out-growth of cartilaginous or bony tissue at the periphery. In this variety the synovial membrane forms villi, but these are less massive and much less vascular. They show the character of chronically inflamed connective tissue, and the bacilli present in the other form are absent.

Schüller confirms the observation that examination by Röntgen rays shows the absence of bony changes in arthritis chronica villosa and their presence in arthritis deformans. He regards the two affections as different in pathology and in clinical characters.

Examination with X-rays has shown that the bones in rheumatoid arthritis may look fragile, as if atrophied, and are more penetrable by the rays than is normal (116). Similar changes were noted by Adams from observations of bones after death (1).

Still describes the post-mortem appearances of joints in three children, the subjects of rheumatoid arthritis, at the Hospital for Sick Children. In two there was marked thickening and vascularity of the synovial membrane, capsule, and ligaments. Fibrillation of cartilage, eburnation of bone, and osteophytic outgrowths were quite absent. The changes resemble those in the arthritis chronica villosa of Schüller.

Beyond the joint changes morbid anatomy shows little that is distinctive or constant.

The muscles show well-marked but not uniform atrophy, some fibres being more affected than others (Debove).

Peripheral neuritis has been present in some cases, and Pitres and Vailliard consider it is constant when there are trophic changes in the skin and muscles.

In certain forms of the disease in children adherent *pericardium* is found with striking frequency (Still), and its presence in adults also has been noted (Bannatyne, A. E. Garrod). Valvular disease is present in some cases, but hitherto its occurrence has been considered accidental, and as the result of previous attacks of true rheumatism.

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[1] For the opportunity of examining these joints the writer is indebted to Miss Stoney, M.D.

Pathology.—The pathology of rheumatoid arthritis is a subject about which the most diverse views have been from time to time held by observers of repute.

Charcot and many French writers have believed that the affection has close affinities with true rheumatism, of which it is a chronic variety.

Jonathan Hutchinson regards the disease as the result of a combination of the rheumatic and gouty processes, in some cases one preponderating, and in some the other.

Arbuthnot Lane's views have already been referred to. He believes that the joint changes are due to merely mechanical causes—that they are essentially local and traumatic in origin. The theory that impaired nutrition of joints is the underlying factor in the production of the lesions characteristic of the disease has had wide acceptance.

Many writers have accepted the theory of an arthritic diathesis, by which is meant, as defined by Hutchinson, a bodily condition which renders a person liable, at some time and under suitable provocation, to become the subject of active arthritic manifestations.

Pye Smith believes the change to be of a senile nature.

Ord has referred the joint affection to peripheral irritation from such various sources as acute rheumatism, gout, traumatism, gonorrhœa, and utero-ovarian disorders, the cord being in a condition of excessive irritability due to anæmia, general exhaustion, or the climacteric. This theory regards the joint affection as the result of reflex irritation of the cord rather than of definite structural change.

That joint affections do arise in connection with gross cord lesions is shown by the occurrence of Charcot's disease in tabes, and by the trophic joint-changes in syringomyelia.

The presence of atrophy of muscles, often extreme, and other associated symptoms, such as abnormal sweating, pigmentation of skin, numbness and tingling, glossy skin, are important evidences of nervous influence.

Folli in two cases found some wasting of the cells of the anterior cornua of the cord, and in a few cases changes in the peripheral nerves have been seen. It is, however, a fact of overwhelming weight that no lesion of the cord or nerves has been found constantly which is capable of explaining the condition of the joint or muscle. Atrophy of muscles occurs also in other joint affections (tubercular and gonorrhœal), in which no question of a central origin is raised.

It has been suggested that the nervous phenomena are due to the effect on nerve tissue of toxins circulating in the blood produced by micro-organisms in the joints. The evidence on which this theory is based is briefly as follows:—

(*a*) That acute cases have points of resemblance to microbic diseases.

(*b*) That acute cases have followed closely some infective illness, such as scarlatina, influenza, acute tonsillitis, otitis media, suppuration behind a dental plate, bone disease, gonorrhœa.

(*c*) That micro-organisms have been found in the joints by Schüller, Bannatyne and Wohlmann, Chauffard and Ramond, von Dungern and Schneider, and others, which are considered by them to be the cause of the disease.

It is probable that previous infective diseases, such as those enumerated, "play some important part in predisposing the tissues to afford an entrance, as well as a suitable nidus for the development of the bacteria" (Bannatyne). If acute rheumatism comes to be included among the infective illnesses, as is in the highest degree probable, the significance of its occurrence in relation to rheumatoid arthritis would be rendered clearer.

If the origin of rheumatoid arthritis be bacterial it may be due—

(*a*) To a specific microbe in the joint, the secondary symptoms (atrophy, etc.) being due to the action of its poisons circulating in the blood.

(*b*) To an intoxication due possibly to a variety of infections, *i.e.* that of gonorrhœa, rheumatism, pyæmia, etc.

Bannatyne, working with Wohlmann and Bloxall, found a very minute organism in the synovial fluid, membranes, cartilage, and bony debris, and rarely in the blood. It is a bacillus measuring $2\,\mu$ to $6\,\mu$. It stains deeply at the two ends, the intervening portion remaining unstained. It may be stained by gentian violet, methyl violet, or carbolic fuchsin, but staining requires care. It grows best in peptone meat broth, and in culture has the appearance of gold dust. It grows also in milk, on agar-agar, and Loeffler's serum. Inoculation experiments have not been satisfactory. This organism has been found in no other joint affection, but has been found by Bannatyne in practically every case examined of rheumatoid arthritis of the acute polyarticular variety. Bannatyne did not find it in the chronic variety with lipping and bony outgrowth.

Chauffard and Ramond found a micro-organism short and thin, a diplo-bacillus, having much the appearance of a diplo-coccus. It stains with difficulty, and grows only in synovial fluid. Inoculation produces no results.

Von Dungern and Schneider obtained eighteen hours after death an organism from the fluid of the knee, wrist, and other joints, and also from the mucus of the gall-bladder. The organism was a small micrococcus closely related to B. lanceolatus. Injected into the knee joint of rabbits it produced lesions similar to those in the joints from which it was taken. The authors regard this organism as the chief cause of chronic arthritis in the case described, and believe that the infection was from a chronically inflamed gall-bladder. It took Gram's stain, and grew best on glucose bouillon.

Schüller finds in the acute form only—the form which he calls arthritis chronica villosa—a short bacillus with polar enlargement, 2·6 μ by ·75 μ broad. It stains readily by ordinary methods, especially carbolic fuchsin, but decolorises easily. It grows on gelatine at 25° C., and on agar as a greyish film. Schüller finds this bacillus in the synovial tissue and fluid of the joint, and his results are chiefly obtained from living tissues removed by operation. It is present sometimes in company with micrococci, or with the gonococcus. He has not found the organism in the chronic form with bony out-growth and lipping, for which he reserves the name arthritis deformans. Cultures of this bacillus have been injected by Schüller into the joints of rabbits, and he succeeded in producing the same villous formations in the synovial membrane which he describes in the human subject.

Schüller states that for the last fifteen years he has examined the urine of patients with arthritis deformans, in the belief that the bone changes are connected with disturbances in the secretion of bone salts. He finds the calcium salts and earthy phosphates of the urine diminished. Further, he finds an increased amount of calcium salts in the cartilage of the affected joint.

Another view as to the source of toxins is that they are produced in the intestinal canal, especially the duodenum, as the result of fermentative changes, and exert a poisonous effect on the spinal cord, and through it on the joints and other tissues. This theory is well worth further investigation.

The rôle of auto-infection in disease is probably considerable, and in the intestine the formation of noxious substances becomes more abundant under a variety of morbid conditions (16). At present the larger number of the substances formed are unknown to chemistry, and the subject is one of great complexity.

The influence of septic conditions of the mouth deserves more investigation than it has hitherto received, and unhealthy states of the oral mucous membrane and gums are undoubtedly present in some cases.

This imperfect sketch of the present position of the pathology of the disease is a mere note to a mass of available material. It seems clear that further classification is necessary before the subject can advance towards solution. There can be no doubt of the importance in the production of the disease of such conditions of mind and body as tend to reduce vitality, and especially such as depress the nervous health. Depressing influences are probably always present in addition to others of a more direct kind.

If it be granted that organisms are a causative agent in the arthritis of certain types of the disease, the evidence of bacteriology up to the present time seems rather to favour the idea that the organism is not specific, but that the characteristic inflammatory changes may be brought about by more than one.

The valuable research of Poynton and Paine has gone far to establish the infective nature of rheumatic fever (94), and has identified a micro-organism which is capable of producing in animals the phenomena of the disease with greater exactness than in earlier experiments.

The subject of chronic arthritis has recently been under discussion by the Chelsea Clinical Society (*Lancet*, i. 1901), and also by the British Medical Association at the Annual Meeting at Cheltenham (*Brit. Med. Jour.* ii. 1901). Dissatisfaction with current theories as to the origin and classification of the various forms of chronic arthritis is apparent in the remarks of speakers in both discussions.

At the Pathological Society of London (*Brit. Med. Jour.* i. 1902), Poynton and Paine reported a successful intravenous inoculation made by them with a diplococcus, isolated and cultivated from fluid in the knee joint of a man of sixty-seven affected with chronic arthritis, and who had died of carbolic poisoning. Arthritis without cardiac lesions was produced in two rabbits. This experiment takes one step further, the probability both that micro-organisms may be important factors in the production of rheumatoid arthritis, and also that more than one organism may be capable of contributing to the production of the chronic inflammatory changes in the joint with which we are familiar.

The *diagnosis* of rheumatoid arthritis does not in a well-marked case present great difficulty.

1. Chronic gout, *with crippling of joints as the result of repeated attacks of gouty arthritis,* may present some difficulty which inquiry into the history should dispel. The deformities of a chronic gouty joint may bear some resemblance to those of advanced rheumatoid arthritis, but in gout chalk stones will usually be present either near the articulation or elsewhere in the body, and a definite history of acute attacks will be obtained. Gout is much more frequent in males, and is *at first* a paroxysmal disease, one or more joints being attacked acutely from time to time, with intervals of immunity, the great toe having a remarkable liability to early attack. Rheumatoid arthritis is progressive from the first, and even if its onset be acute, the joint affection does not clear up, but steadily increases from the time of attack.

Acute *articular* gout is a decidedly rare affection in women of the present day, but the immunity of even young women cannot be wholly relied on. The writer is acquainted with an acute case in a girl of nineteen.

It is of the highest importance for the patient's welfare that so serious a mistake should be avoided, for the principles of treatment in the two affections are wholly different, and nothing is more calculated to aggravate and confirm rheumatoid arthritis than to subject the sufferer from it to a régime suitable for the treatment of gout.

2. *Acute rheumatism* may be closely simulated by acute rheumatoid arthritis, and for the first few days the distinction may be impossible. The points which are most helpful are :—

(*a*) The joints attacked in acute rheumatoid arthritis are usually the small peripheral joints, and there is no tendency to rapid migration from one to another. Those first attacked remain affected, and soon show characteristic changes.

(*b*) Cardiac complications are less likely to occur, but are known. In adults this distinction is less valuable, as cardiac complications in true rheumatism are markedly less common in them than in children.

3. *Chronic rheumatism* is a condition ill-defined and variously understood. That most likely to be confused with rheumatoid arthritis is the condition called by Jaccoud "rheumatism fibreux." His cases occurred after repeated attacks of acute rheumatism. Patients complaining of so-called rheumatic pains have usually a history of true rheumatism in themselves or their families, or are the subjects of rheumatoid arthritis.

4. *Gonorrhœal arthritis* presents some points of decided resemblance to rheumatoid arthritis. It does not migrate, but persists in the joint or joints first attacked, and the temporo-maxillary joint not rarely suffers. It is more common in men, and the larger joints are attacked rather than the smaller. Suppuration is rare, but not unknown, and there is a marked tendency to the formation of fibrous adhesions, but none to bony out-growth.

Acute myositis has been recorded in this affection, and iritis and conjunctivitis occur. In women a history of gonorrhœa is elicited with difficulty, and diagnosis has to be made by exclusion, if at all.

5. The extreme atrophy of muscles, in some cases out of all proportion to the joint affection, may lead to a diagnosis of progressive muscular atrophy. Ord mentions this possible resemblance. Payne thinks there is

comparatively slight atrophy of the thenar and hypothenar eminences, and hollowing of the palm in rheumatoid arthritis.

6. Bouchard notes the occurrence of enlargement of the base of the second phalanx of the fingers in association with dilatation of the stomach, and considers this affection should be separated from rheumatoid arthritis.

7. Charcot's joint disease, the arthropathy of tabes dorsalis, is thought by some writers to have the same pathology as rheumatoid arthritis, the suggestion being that the disease is rheumatoid arthritis occurring in a patient profoundly debilitated by his cord disease. Clinically striking features are the complete absence of pain in the joint in association with degenerative changes so pronounced that its functions are in abeyance. Both knees may be full of fluid, and so disorganised as to form complete flails, yet no pain is felt, and the patient may even get about if the joint is fixed by an immovable splint.

8. The pain and rigidity due to involvement of the vertebral joints have been mistaken for spinal caries, and some care is needed in distinguishing between these affections, especially in cases where caries occurs late in life.

Prognosis.—The joint affection once started has no spontaneous tendency to recover. It is essentially chronic, and to a greater or less extent progressive in its course, the joint attacked being permanently injured or completely disorganised.

Treatment can do something to modify the unfavourable course of the illness, but to be effective it must be begun early and continued with untiring patience. When a joint is crippled and distorted by gross structural changes treatment can do but little to restore it to the normal; but if the disease be recognised early, before such changes have been produced, much can be done in many cases to prevent their appearance, and to ameliorate the condition of the patient. In some early cases the disease may be completely arrested.

Treatment.—Garrod laid down the principle that this disease must be treated by means (*a*) calculated to improve the general health, by a highly nutritious diet, and by tonics, especially such tonics as have a direct effect on the anæmia, and (*b*) by such local means as are calculated to improve the nutrition of the joint, and to prevent their becoming fixed and useless. Of a tonic treatment the importance cannot be over-estimated, and possibly a more hopeful view of the disease might be taken if it came under observation earlier, and if the treatment were always such as is suited for the arrest of the disease.

The *diet* should be as nutritious as the patient can assimilate, and should contain a sufficient quantity of red meat, in any form in which it can be taken, and of fats. A diet consisting wholly or chiefly of meat has been used extensively in this disease, and is considered by some to be of service. This diet is based on a work published in New York by J. H. Salisbury. Where the digestion of farinaceous food is difficult, and apt to lead to excessive fermentation, a diet consisting chiefly of meat may be useful, but it is not suitable to all patients, and some are quite unable to adopt it, and lose weight rapidly. Probably most patients will do best on a mixed diet.

Alcohol is useful in most cases in moderate daily amount, and with food. Sound red wines are the most suitable, but malt liquors are not contra-indicated as in gout, and stout is sometimes useful if it can be digested.

A low diet, and especially the limitation of red meat, is decidedly contra-indicated, and has an unfavourable effect on the course of the disease. The use of cream and butter should be encouraged.

Digestion and appetite are often impaired in the more debilitated patients, and feeding them suitably becomes very difficult.

Clothing should be light and warm—preferably of wool. It is important that the extremities, and especially the affected joints, should be carefully protected from cold.

Exercise should be persevered in so far as possible, though not to the extent of greatly increasing pain and fatigue. When exercise becomes difficult, the nutrition of the joint should be kept up by rubbing or careful passive movements, and the patient should still be encouraged to use it as much as possible.

Fresh air is of benefit to these patients. They should live in a climate where outdoor life, without exposure to cold and damp, is possible. A dry soil, a high average of sunshine, slight daily variation of temperature, and a moderate elevation, are the most suitable climatic conditions. Winter in a warmer and more equable climate than England is desirable, but in the south of England localities can be found which are fairly well adapted to the needs of these patients. Sea-board and the beds of rivers should probably be avoided. Egypt suits well where the patient can travel without great difficulty.

As regards *drugs,* much benefit is derived from the use of tonics, iodine, and cod-liver oil, given over long periods. The most useful tonics are arsenic, iron, and quinine. Garrod laid stress on the great value of the iodide of iron in combination with arsenic. Arsenic should be persevered with steadily, with occasional intervals, and is perhaps more usefully employed in small doses for a lengthened period than when given in larger doses, which cannot be continued so long. The dried sulphate of iron in pill with arsenic is a useful combination. The iodides are of great value, but should be combined with tonics. Iodide of potassium alone has an unfavourable effect on the general health, which is not compensated by the relief it may afford to the joint pain. Cod-liver oil is highly beneficial, and patients should be encouraged to continue its use.

For the relief of pain hyoscyamus has been recommended.

Bannatyne and others, who believe that the acute forms of the disease have a bacterial origin, have employed with benefit drugs which are supposed to be antidotal to micro-organisms, or their products, when given internally. Bannatyne has employed the creasotes and guaiacols, the phenols (salol and salophen), and the naphthols, and believes that the creasotes have a more or less specific action on the disease, that the phenols are useless, and that the naphthols are of much use by reason of their effect on the contents of the intestine. He recommends the employment of carbonate of guaiacol, gr. v.-x. t. d. s. in cachet.

The salicylates reduce pain and fever in the acute stages, but should not be persevered with. Colchicum, invaluable in gout, is contra-indicated here.

Aspirin (salicylo-acetic acid) in doses of gr. x.-xv. relieves pain markedly, and can be taken over considerable periods without producing the depression which limits the usefulness of the salicylates in these cases. It is conveniently given in cachets, and is of decided value.

Ichthyol internally has been recommended, but reports are conflicting as to its value.

Baths have long been held in repute as a treatment for rheumatoid arthritis, and are of great value in properly selected cases. Baths are not indicated for the elderly and debilitated, who may be decidedly the worse for them, but benefit chiefly early cases, and those in whom the general health is fair, and where the joint affection has not advanced far towards hopeless deformity.

Baths necessitating long immersions are not advisable, and probably douche-massage, first practised at Aix-les-Bains, and admirably carried out there, is the most useful form. The exact chemical properties of the water employed is of less importance than skill and care in manipulation, but there is value in thermal water.

Bracing air is a decidedly valuable adjunct to treatment by bathing.

In this country Harrogate, Woodhall Spa, Buxton, and Bath have a reputation for the treatment of rheumatoid arthritis, and the three first named have the advantage of highly bracing air. At Bath the methods of Aix-les-Bains are carefully followed, and the water is thermal.

Llandrindod Wells and Droitwich are advised for these patients, and at Strathpeffer mud-baths are given as well as other treatment. The mud-baths of Ischl (Austria) are in high repute, and those of Acqui (N. Italy) have local renown. Acqui also possesses hot sulphur springs. Barèges (Hautes-Pyrénées) is a celebrated spa, but does not offer such luxurious accommodation to visitors as Aix. Wiesbaden is much frequented.

Where anæmia is marked a course of natural iron water at one of the ferruginous spas, such as Schwalbach, may be useful. The iron water of Flitwick is of decided value where digestion is weak and the ordinary preparations of iron disagree.

Electric baths have been much recommended. They should be employed only by skilled persons. The course needs to be long, two or three baths a week for two or three months. Such prolonged courses of baths would seem to be open to some objection. Turkish baths and vapour baths give temporary relief to pain and stiffness, but these baths repeated frequently are not beneficial and should be discouraged.

After a course of baths an after-cure spent in high and bracing air is of great benefit, and should, if possible, always be taken. In advising a course abroad it is well to warn patients to avoid the hottest months of the season. Baths during extreme heat may be followed by considerable exhaustion and decided increase of anæmia. One course of baths is rarely sufficient to effect the greatest possible amount of benefit. A second course should be taken after an interval varying according to the patient's condition, but never less than a year.

Heat locally to joints is a favourite treatment and has undoubted value. Probably dry heat is more efficacious than moist. A simple method is the hot sand bath, it can be employed wherever sand and an oven are available, and for the hand and wrist is specially useful. The limb is plunged into sand as hot as it can be borne, which is renewed as it cools.

Various methods of applying to affected joints dry air raised to high degrees of heat are in use. In the Tallerman method the heat is obtained from gas, the apparatus is of the nature of a gas stove, shaped so as to receive a limb. In the Dowsing and Greville methods the heat is generated by electricity, in the former by means of electric lamps, with reflectors of glass and metal, in the latter by means of small wires in a frame of aluminium. These methods need skilled application and special apparatus, and are necessarily expensive, but the relief obtained is in some cases very striking.

Massage is of value in keeping up the nutrition of muscles and preventing stiffness and fixation of joints. It relieves pain markedly in some cases. In association with the douche it is a most valuable treatment.

Cold has been recommended for the relief of pain, either locally in the form of ice-massage (Ewart) or by means of the spinal ice-bag. Ewart advises slowly rubbing the joint with a lump of ice once or twice a day, as a successful treatment when hot application fails.

Kinnear states that the application of the spinal ice-bag from half an hour to three hours a day relieved the worst cases when every known remedy had been tried and had failed. This author considers the ice-bag improves nutrition and circulation.

Electrical treatment apart from baths has been much recommended. Probably the constant current is useful in improving the nutrition of muscles. Static electricity is said to be of value as a general nerve tonic.

Surgical procedures have been employed in the following ways, though none but forced movements are at all generally used in this country:—

1. Operations on joints have been undertaken for the relief of ankylosis when the joint is fixed in a bad position, *i.e.* in the elbow or the temporo-maxillary joint. Collinson has had successful cases. He considers that operation is only applicable in young patients and where the muscles are not excessively atrophied.

Forced movements under an anæsthetic to break down adhesions are employed. They are not free from danger, and may set up acute inflammatory changes.

2. Schüller and others operate on joints for the purpose of removing diseased tissues, especially the synovial membrane.

3. Schüller has also treated cases by intra-articular injection of sterilised guaiacum-iodoform-glycerine. These procedures have for their object the removal or destruction of the organisms, which the author considers are the cause of the arthritis.

External application of various medicinal substances is employed largely. Iodine painted on the joint or applied as an iodine plaster is useful. Tincture of capsicum applied on lint after washing the joint with hot soap and water may give decided relief. A liniment of chloroform, belladonna, and aconite in equal parts has been recommended. Bannatyne advises the use of equal parts of guaiacol and olive oil, or guaiacol with tincture of iodine (1-6), or guaiacol with methyl salicylate. The guaiacol is absorbed and can be detected in the urine. Its smell is a decided practical objection to its external employment.

Unhealthy conditions of the gums, especially such as are attended with purulent discharges, should be treated. Recent work makes it probable that chronic septic diseases of the mouth play an important part in auto-infection and the etiology of diseases which depend upon it. Affected parts should be cleansed thoroughly with 1-20 carbolic lotion and an antiseptic mouth-wash used frequently; salicylic acid (1-600) or Condy's fluid well diluted, or Listerine, are satisfactory for this purpose.

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VON ZIEMSSEN. *See* SENATOR, H.

Chronic Rheumatism

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Clinical Features.—The clinical features of chronic rheumatism are for the most part vague and ill-defined. The leading manifestations are seen in relation to joint structures, especially the larger joints of the limbs and spine, but many other tissues may be the chief sites of incidence of the rheumatic virus. Among these other manifestations rheumatic affections of muscles occupy a prominent place, and as these are very frequent and apt to be overlooked, special attention is devoted to them (p. 441). The skin, subcutaneous tissue, and the special senses of ear and eye frequently exhibit symptoms often regarded as of rheumatic origin. While there is a diversity of opinion on the relationship of these symptoms to rheumatism, the balance of evidence indicates an important relationship. Among the diseases here referred to may be mentioned erythema, psoriasis, lichen, iritis, and chronic middle ear disease. In children many other subacute and chronic indications of disease are of rheumatic origin (*vide* "Rheumatism in Children," p. 400).

The clinical features of chronic rheumatism are perhaps best illustrated by short records of cases met with in practice. Those selected are characteristically common types, and it is needless to say that every grade of severity and various combinations of these types are met with in everyday practice. The probable relationship of these various types to each other will be referred to later under the etiology of the disease.

Mr. L., æt. 30.—Chronic myositis of the neck muscles; recurring arthritis in left hip and knee; deafness of middle ear origin (non-suppurative); acne and blind boils.

The hereditary history showed a distinct tendency to rheumatism. The joint trouble was confined to the left side, a feature which was probably correctly attributed by the patient to the results of a previous injury to the thigh, through being heavily thrown from a horse. The patient complained of a marked sense of discomfort in the head and neck, but had become accustomed to this feeling, and did not associate it with a local condition. Examination showed that the muscles at the back of the neck were unnaturally firm and contracted, the movements of extension and rotation of the head were restricted, the hip joint revealed creaking and limitation of movement; examination of the ear showed that the tympanic membrane itself was apparently normal, the structural changes in the middle ear were obviously of articular origin.

This case illustrates three interesting points—

(i.) A definite lesion in the muscles—chronic myositis (probably also cellulitis), a condition that is common and apt to be overlooked.

(ii.) The tendency to develop manifestations of rheumatism in a joint previously weakened, *e.g.* by a trauma, etc.

(iii.) The coexistence of the local disease in the ear with a general constitutional disturbance.

(iv.) A special liability to the pathogenic influence of bacteria on the skin surface.

Mr. M., æt. 46.—Chronic rheumatism in left shoulder joint; otherwise in apparently perfect health.

Mr. M. regards himself as in perfect general health. The only things that trouble him are his left shoulder and, occasionally, fleeting pains in other parts of the body. The joint condition has developed slowly, and has never been seriously treated. There is no distinct rheumatic history. The shoulder joint shows distinct muscular atrophy, limitation of movement, occasional creaking, and some irregularity at the head of the bone. Subjective symptoms are, as a rule, only complained of after a day's outdoor exercise, after which the left arm is for a time practically useless. There is no history of gonorrhœal infection in this case.

This case illustrates a very localised area of naturally weak power of resistance to the action of the rheumatic poison.

Mr. N., æt. 70.—Attack of subacute rheumatism when æt. 45; chronic arthritis in the knee joints since æt. 65; deafness of nerve origin.

Mr. N. leads a most active life physically and mentally; his general health is regarded by himself as excellent. He lives well, and has always done so. His joint disease makes him distinctly lame, but the pain complained of is inconsiderable, and always worst in the morning and on rising from a chair or couch. The right knee joint is most involved and is markedly enlarged, the swelling appearing to be largely confined to the soft tissues, especially in the anterior and superior aspect of the joint. There is well-marked creaking, but no new bony formations can be made out. The movement of flexion of the knee is restricted, and the hamstring muscles are strongly contracted.

This case is chiefly interesting as showing—

(*a*) An acute onset (when æt. 45) of a rheumatism which was *apparently* distinct from an ordinary attack of rheumatic fever.

(*b*) The association of a local disease in one of the special senses, along with the general manifestations.

(*c*) A fairly strong power of resistance to the virus of rheumatism, indicated by the limited nature and severity of the disease in a man of this age and history.

Mrs. O., æt. 60.—Rheumatoid arthritis, acute onset; chronic rheumatism.

At the age of 50 patient suffered from acute attacks of pain and swelling in the joints of the hands, ankles, and, to a less degree, of the wrist. The pain was evidently severe, as she was kept under morphia for some time. About the same time she began to complain of stiffness and weakness in the muscles in different parts of the body, a feature which persisted more or less for years, and is still present. Treatment by a change of climate, hydro-therapeutic measures, diet, and massage seemed to exert a favourable influence on the disease. Since the age of 55 the joint lesions have not progressed, but since that time she has had one severe attack of brachial neuritis, and an acute attack of lumbago, and has been intermittently subject to marked pain and weakness in the limbs, and severe cramp in the muscles of the legs at night. At the present time there is considerable enlargement of all the joints of the hand, except the terminal joints, with distortion of the fingers, but no pain or limitation of movement. There is marked local muscular atrophy. One striking feature of this case which attracted the patient's own attention was the state of the urine. It has persistently had a very strong odour, and was described by the patient as being frequently offensive. This patient is an interesting and by no means uncommon type of case, which illustrates the very close relationship that exists between rheumatoid arthritis and so-called chronic rheumatism.

Comparative Pathology.—Our knowledge of the clinical features, pathology, and treatment of rheumatism in the lower animals is in the same incomplete state as our knowledge of these affections in man. Horses, cattle, dogs, and pigs are known to be the subjects of disorders which in their clinical features present a close parallel to those affections in the human subject, and from a study of these diseases we may gain valuable information regarding the etiology of kindred affections in man. For our present purpose we may consider that the crucial question is, Do we find in the lower animals diseases which are clinically and pathologically identical with the following diseases as at present recognised in the human subject?—

(i.) Acute rheumatism.
(ii.) Chronic rheumatism.
(iii.) Rheumatoid arthritis or osteo-arthritis.

In answering these questions it will appear that veterinary surgeons have seen no reason to distinguish, or at least have not distinguished, chronic rheumatism and rheumatoid arthritis as two classes of disease. They simply differentiate them by the measure of severity in the involvement of the joints. The writer has devoted some attention to comparative pathology, and in addition to the knowledge derived from a direct clinical study of these conditions in the lower animals, he has obtained much information from available literature, as well as from friends in the veterinary profession.

(i.) *Acute Rheumatism.*—Animals are liable to an acute fever, characterised by a more or less sudden onset of high temperature, with painful enlargement of and effusion into the joints. The wrist and ankle are the joints most affected, and in them the pain is extreme. Metastasis is a prominent feature of this disease. Endocarditis and other cardiac conditions are frequent concomitants, and may lead to a fatal termination. The result may be (*a*) death from cardiac inflammation, (*b*) complete recovery, or (*c*) incomplete recovery, some local weakness being left in the affected joints. It is interesting to note that this disease is relatively more common in cattle than in horses. The analogy to acute rheumatism in the human subject is reasonably complete.

(ii. and iii.) *Chronic Rheumatism and Rheumatoid Arthritis.*—Symptoms attributed to chronic rheumatism and rheumatoid arthritis are extremely common in the lower animals, especially in horses, dogs, pigs, and cattle. We may say at the outset that, as less is known about the clinical features and morbid anatomy of these two conditions in animals than in man, it is necessary to discuss them together, merely submitting a brief outline of the clinical features and pathology on which their diagnoses are based. So far as I have been able to learn, the term rheumatoid arthritis, or more commonly osteo-arthritis, is applied to the cases which exhibit a more severe involvement of the joint, *e.g.* much irregular formation of new bone, muscular atrophy, with marked permanent disablement; while the term rheumatism is applied to a less severe articular lesion and to involvement of muscles, tendons, and tendon sheaths, bursæ, and nerves. The former class is naturally comparatively rare, as such animals are commercially useless, and are destroyed at a comparatively early stage of the disease, while in the less serious type of rheumatism, with less severe articular symptoms, the animal is able to do a fair amount of work. Thus we find that these latter cases form a not inconsiderable proportion of the subjects that come under the veterinary surgeon's care. It is convenient to consider this condition under the following headings:—

Articular Type of Rheumatism other than Acute.—(*a*) *Chronic.*—The disease is mainly, but by no means entirely one of adult life and old age; cases in young animals, four and seven years, are by no means rare. The usual sites are the hip, spine, ankle, and wrist, but any joint may be involved. The clinical features are stiffness and pain in the limb, with swelling of the joint. The enlargement is due to an increase in the articular ends of the bones, or in the soft tissues entering into the formation of the joint. In some cases it is due to involvement of the bursæ or tendons in close proximity to the joint. Marked creaking may be elicited on movement of the limb. Investigation also may show that this animal never lies down at night, a symptom usually attributed to ankylosis of the lumbar spine. It is not an uncommon thing to find in a large stable of horses one or more animals in active work that are partially slung up at night so as to prevent them lying down. This precaution is advisable owing to their inability to raise themselves. Such an animal is very stiff in the morning, and may require a little exercise before being fit for even a light day's work. The creaking heard on movement may be due either to disease in the joint or in the muscles surrounding it. The muscles and tendons on the flexor aspect of the joint are usually unduly hard and contracted. In mild cases, when the animal gets warmed to his work, all stiffness and lameness may disappear, and nothing further may be determined about the case except that he is subject to constipation, and voids urine that is turbid and evidently unduly charged with salts of various kinds. A careful examination into the history will usually reveal the fact that the animal drinks too little, or, to put it more accurately, he does not get the opportunity of drinking enough. Here, then, we have a clinical picture of disease, the prototype of which comes within daily observation of the medical practitioner.

(*b*) *Subacute.*—Subacute manifestations of rheumatism are extremely common, and in this group we find the most striking illustrations of metastasis. These metastatic manifestations are frequently of an acute nature, with pain, effusion, and elevation of temperature, but to a much less degree than is characteristic of the acute cases previously described.

(*c*) *Abarticular type.*—This group includes acute and chronic cases. The former are characterised by acute pain and swelling of the tendons and other soft tissues in the neighbourhood of a joint. The symptoms may be so severe as to prevent the animal rising for several days. This type of disease is not, as a rule, accompanied by any febrile reaction. The chronic group includes many cases of "spavin," "ringbone," and other conditions characterised by local formation of new tissue of a bony or other nature in the neighbourhood of joints. Mention must also be made of cases of lameness that are supposed, by a process of exclusion, to be dependent on a neuritis of a "constitutional" or "rheumatic" nature.

(*d*) *Rheumatoid or Osteo-Arthritis.*—As already indicated, this term is applied to the more severe type of cases of chronic rheumatism, when the articular changes are more advanced and of a more markedly hypertrophic nature. The subjects in this group show greater muscular weakness, and usually advanced local muscular atrophy. It is important to note that this disease is sometimes well developed in quite young subjects; a few cases have been recorded from zoological collections.

It will be seen from the foregoing that, so far as clinical features are concerned, the diseases of a "rheumatic" origin in horses correspond very closely to the same diseases in the human subject. What differences exist are probably of degree rather than of kind, and are readily explained by the different life histories of the two subjects. When we turn to the pathology we will find that the comparison holds good.

Pathology.—The writer has examined many of these cases (groups *a* and *d*), and has found that the joint changes are very similar to those encountered in cases of chronic rheumatism and rheumatoid arthritis in man. In many cases the description of joints in chronic rheumatism (vol. v. p. 25) may be fitly applied. In others the appearances more closely resemble that recorded for osteo-arthritis in its earlier stages (vol. x. p. 425), and also the lucid description of traumatic arthritis given by Arbuthnot Lane. So far as the writer's observations go, the morbid anatomy hardly warrants any distinct classification. The differences appear to be of degree rather than of kind. This subject is further referred to under etiology.

Treatment.—It is beyond the province of this article to refer to treatment except in one particular. We have already seen that clinical experience and pathological investigation show a close parallel between these affections in the lower animals and in man. Confirmatory evidence is obtained from the field of therapeutics. To speak generally, veterinary surgeons treat these affections in one of two ways: (*a*), by rest and the adoption of local measures, mainly of a counter-irritant nature, and (*b*), by a limited amount of exercise, a laxative diet, and plenty of water. The balance of opinion is in favour of the latter course—a fact not without its lessons to the medical practitioner. With regard to diet, if space had allowed, many interesting facts could be quoted regarding "chronic rheumatism" in other animals, *e.g.* pigs, and the relationship of diet to that condition.

Morbid Anatomy.—The naked eye features of a chronic rheumatic joint in the human subject are very similar to those met with in the lower animals. In both the joints are unnaturally dry; when fluid is present, it is altered in colour and consistence. There is the same tendency to irregular enlargement of the articular ends of the bones. The tendons and tendon sheaths in the neighbourhood of the joints show the same congestion of vessels and evidences of recent and old cell proliferation. The cartilages may be thickened or thinned, and may show vascularisation and ulceration. The synovial membranes show a varying degree of thickening and undue vascularity, and in some cases irregular villous projections. There is a further correspondence between the two classes of rheumatic subjects in that no two cases, and even no two joints in the same case, present exactly the same appearance. This close parallelism, however, is of little value for the etiology of the disease. The gross structural changes which take place in the affected joints must be set in relation to the other changes induced in the tissues, and it is probable that the facts of a more general morbid anatomy will prove of much greater importance for the discovery of the cause of chronic rheumatism than the facts of those articular changes to which attention has been too exclusively confined.

With regard to the remaining vital constituent of the morphological joint unit—the marrow—I know of no observations on the human subject as to the state of this very important tissue in this disease. In the course of an examination of many subjects in comparative pathology in which symptoms of rheumatism had been present, the writer has frequently seen definite gross changes in the bony system other than the articular ends. These changes were mainly of the nature of (*a*) altered colour and appearance of the marrow, a varying degree of redness and gelatinous degeneration being present; (*b*) altered consistence of the marrow due to sclerosis and calcareous changes in that tissue. Owing to an insufficient acquaintance with the normal appearance in animals at different periods of life, it is not possible to speak with assurance as to the character of these pathological changes and their relation to the general rheumatic condition. But as to the existence of gross changes there is no room for doubt, and, to my mind, little reason for doubting that these have a close etiological relationship to the disease itself. This field of study is a wide and important one. Till now, the pathological histology, like the morbid anatomy, of these cases has taught us little about the cause of chronic rheumatism, and until we have given adequate study to the bone marrow and its function, we shall be unable to formulate with confidence a theory as to the etiology of the disease.

A further desideratum in human pathology is an exhaustive examination of the naked eye and microscopic appearances of all the viscera and tissues in cases either of rheumatism or so-called rheumatoid arthritis. In both classes of case we are too ready to conclude that visceral lesions, if present, are relatively unimportant or incidental complications. What is desirable to have even in one case of this kind is a complete histological examination of all the tissues of the body. Very special attention should be directed to the following:—

(*a*) *Very detailed examination of the vessels*—small and large—concerned in the nutrient supply of the joints, muscles, nerves, or other tissues that were the seat of the clinical manifestations. Attention has lately been drawn to the presence of disease in the arteries and capillaries in some cases of acute rheumatism (see p. 385); it is probable that similar local changes of a more chronic nature may help to explain some of the fleeting manifestations of chronic rheumatism.

(*b*) Similar *examination of the various mucous surfaces* that are the common sites of infection for bacterial invasion—more especially the gastro-intestinal canal and the utero-vaginal membranes. The facts learned from this examination would be many, and could not fail to be very instructive.

(*c*) The naked eye and microscopic *appearance of the marrow.*

With these facts and the others obtainable from present records, we would be in a better position to review the whole picture of rheumatism, and would also be in a stronger position for formulating a theory regarding its pathogenesis. But these facts are absolutely essential.

RHEUMATISM, MUSCULAR.—In rheumatic subjects the muscles are affected in two ways—as an acute or a chronic myositis. Both conditions are apt to escape notice on account of the small amount of attention that is paid to the systematic clinical examination of the muscular system. It is sometimes stated that where there is evidence of active inflammatory change in the muscles the condition is to be regarded as myositis, and no longer as muscular rheumatism—the latter name being reserved for those cases in which no objective signs are present. This is surely an erroneous view of the subject; there is much evidence in favour of the view that so-called muscular rheumatism stands in a very direct relation to other manifestations of rheumatism, and a study of the manner in which the muscles are affected is essential to a complete survey of rheumatism.

Acute Myositis.—Acute myositis is met with at any period of life, but is more common in the later half. The female sex is more liable, and stout subjects especially so. The clinical features vary according to the extent and severity of the disease. The patient may complain of "neuralgia," or of "rheumatic pains" in a joint, or of weakness in a limb. Little pain may be complained of when at rest, but on exertion, *e.g.* rising from a chair, an acute twinge of pain is experienced. In cases of some duration and severity the amount of discomfort or pain is considerable, as are also the pains of the limbs as a whole, and especially the weakness in the joint nearest the muscles involved. On examination of the affected muscle nothing will be found unless a most careful and detailed examination, especially adapted to determine the presence of inflammatory thickening in the muscles, is carried out. The examination is made as follows:—The patient must be directed to put the muscles into a passive state, as a contracted state of the fibres will interfere with the examination. The skin is smeared with vaseline. The muscle is then gently palpated with the finger-tips, the examination being conducted along as well as across the line of the fibres. The movement of gentle petrissage (see THERAPEUTICS) is well calculated to reveal the presence of foci of rheumatic inflammation. A patch of inflammation reveals itself by marked localised tenderness, which makes the patient wince keenly. The painful spot is usually the size of a bean, but may be smaller or considerably larger. To the finger the spot feels hard in the centre and surrounded by an area of unusual softness, presumably an area of serous exudation. These spots are usually multiple, and a careful examination may reveal their presence in regions unknown to the patient. The muscles most commonly affected are those on the front and sides of the chest (pleurodynia), thighs, neck, legs, and abdomen, but practically all the muscles of the body may be involved.

Chronic Myositis.—The typical picture of a case of chronic myositis is quite distinct from the foregoing, but here also the clinical features are not such as direct attention specially to the muscular system. The patient may complain of—

(i.) Rheumatism, involving mainly one or more of the larger joints. It is advisable to note that an objective examination may reveal definite articular changes which distract attention from the more important lesion in the muscle.

(ii.) Neuralgia.—Especially of neuralgic pains in the occipital region or back of neck, thighs (sciatica), or lumbar region (lumbago).

(iii.) Headache and general discomfort in the head and neck are sometimes the leading symptoms complained of.

(iv.) Precordial pain, or pain in the mammary region.

On objective examination the affected muscles are found to be in a state of contraction. They are unduly hard throughout their whole extent, and when their action is tested, their movement is found to be unduly limited and markedly painful. In the affected part there may be none of the acutely painful areas characteristic of the acute condition, but careful examination may reveal their presence in another region of the body. The muscles most involved are the same as those already mentioned. Special mention should be made of the muscles attached to the occiput and neck, to the intercostal and serrati and gluteal muscles.

Diagnosis.—The differential diagnosis is, as a rule, easy, provided a careful examination of the muscular system be carried out. The following diseases are simulated, and muscular rheumatism may be mistaken for—

(*a*) Joint disease.—Pain and stiffness is often referred to the joint which may be in a state of flexion. This is especially seen in the knee, hip, and shoulder.

(*b*) Visceral disease, especially pleurisy, or some disturbance in the gastro-intestinal tract, *e.g.* gastralgia, appendicitis.

(*c*) Cardiac disorder or disease of the mammary gland in women. Symptoms attributed by the patient to these conditions are not infrequently due to rheumatic inflammation in the muscles of the chest wall.

(*d*) It may not be possible to differentiate myositis from similar small painful nodules met with in the subcutaneous tissues due to a *local cellulitis,* which is practically identical in its origin and nature with the areas of inflammation in the muscular tissue. From a practical point of view an accurate diagnosis is immaterial.

It is only necessary to mention the presence of small subcutaneous fibrous nodules sometimes met with in the subcutaneous tissue or attached to tendons, seen especially in the forearm. These are apparently small fibrous nodules of local origin and do not call for treatment.

(*e*) *Neuralgia.*—The frequency of these distinct inflammations in muscles is probably not sufficiently realised, and not a few cases are diagnosed as "neuralgia." The writer believes that some cases diagnosed as brachial neuralgia are really cases of myositis involving the muscles of the neck; occipital neuralgia, due to inflammation of the deep muscles, especially the complexus; sciatica, due to local changes in the glutei muscles, and some cases of lumbago due to a similar state in the lower fibres of the trapezius or deep muscles of the trunk.

In the more chronic cases, *e.g.* in the neck, it may be quite impossible to say whether the structural change is in the muscles of the part, in the subcutaneous tissue, in the nerves, or in the joints of the spine. Some assistance in the diagnosis may be forthcoming from the result of treatment. After one day's treatment by gentle effleurage the skin over the inflamed portion becomes yellow, and later assumes a darker tint, the colour disappearing in three to four days, and by that time the affected limb, which previously felt heavy, dull, and paralysed, feels alive and in a much improved state.

General Diagnosis.—Some important points in the diagnosis of rheumatism have already been detailed in the section on "Muscular Rheumatism."

Firstly, It is advisable to determine as far as possible the exact site of the pathological process. Is it in the muscle, subcutaneous tissue, nerve, or in the neighbouring joint? The accurate determination of this point may materially modify the prognosis in a given case.

Secondly, The existence of any gross visceral disease ought next to be determined by an examination in turn of the gastro-intestinal, renal, cardiovascular, and nervous systems. In women special attention should be directed to the menstrual function. When gross visceral disease is detected, we should not at once consider that such is a merely incidental complication of the rheumatism, as in most cases it is probably closely identified with it, etiologically, pathologically, and clinically.

Thirdly, In doubtful cases of articular rheumatism it is not necessary to differentiate precisely the various types of osteo-arthritis, as the relationship between that disease and so-called articular rheumatism is probably a close one, and the principles of treatment are essentially the same.

Fourthly, With regard to gout—what has been said of articular rheumatism holds good also with regard to gout. It is sometimes said that great care is necessary to differentiate cases of joint disease, the result of chronic gout, from cases to which, on clinical and pathological grounds, the term osteoarthritis appears more applicable, as the dietetic and general treatment is so different in the two cases—the first calling for depletory, the latter calling for more stimulating measures. But this difference in treatment is only sound in a restricted sense, *i.e.* with reference to the later stage of the disease, when we are treating the results of the disease. In the early stages of both diseases the principles of treatment (*vide* article "Gout," vol. iv.) are the same.

Etiology.—The etiology of chronic rheumatism is quite unknown, and we do not possess evidence sufficient to warrant a definite theory being put forward for the causation of this disease. We have already pointed out the advisability of obtaining new facts which might materially advance our knowledge, viz. (*a*) the state of the vascular system—especially arteries and capillaries—in the affected tissues; (*b*) the histological appearances of the various free mucous surfaces in the body—especially the gastro-intestinal tract and utero-vaginal mucous membrane; and (*c*) fuller and more accurate information on the naked eye and microscopic appearance of the bone marrow. If to these we were to add the results of an investigation into the combination of various gross and minute changes in the renal, cardio-vascular, and nervous systems with chronic rheumatoid and rheumatic changes in the same subject, I believe a new chapter on the etiology of the disease could be written. And if we were to avail ourselves more of the wealth of clinical material obtainable from diseased subjects in the lower animal kingdom a great advance in our knowledge would be assured, for the study of these subjects can be conducted with greater ease, and is productive of results at once fuller and more precise than is possible in the case of the human subject. In the absence of this necessary information we shall only refer briefly to some of the views in vogue regarding the relationship of these diseases to each other, and thereafter merely mention a view which seems to present at any rate a *prima facie* case for a careful consideration. Three critical queries suggest themselves:—

Firstly, Is it wise to accept the general tendency at the present time to regard rheumatoid arthritis and true rheumatism as maladies essentially distinct and widely differing in their pathology?

Secondly, In our zeal for classification and recognition of types, may there not be a tendency to fail to recognise certain general pathological principles underlying all these diseased processes?

Thirdly, Should we regard "muscular rheumatism" as a disease *sui generis*, not closely connected etiologically with articular and other manifestations of rheumatism?

There would appear to be many facts which suggest that acute rheumatism, chronic rheumatism, and rheumatoid arthritis are in reality closely related to each other, the varied clinical and pathological pictures merely representing different individual reactions to the same cause or group of causes. The grounds for this belief can only be briefly stated—

(*a*) In practice there are frequently extreme difficulties in differentiating between acute rheumatism and acute polyarticular rheumatoid arthritis. In not a few cases the diagnosis is impossible.

(*b*) It is well known and generally recognised that a typical pathological picture of rheumatoid arthritis may develop as a sequel of infection of the system with the virus of gonorrhœa and, more rarely, of other pathogenic bacteria.

(*c*) A frequent investigation of all the cases of a rheumatic or rheumatoid nature in the hospital wards of a large workhouse has convinced me of what may be termed their hybrid nature in a very large proportion of the cases seen.

(*d*) We find a good deal of evidence in favour of the idea of some unity in the causation of these diseases in the writings of living authorities on these special departments. Thus it is admitted "that there are cases in which deformity results from acute rheumatism and remains permanent. Such cases, though they resemble rheumatic fever in their varied manifestations, are in the character of the changes in the joint more akin to rheumatoid arthritis" (Poynton, see p. 400). In his article on rheumatoid arthritis in children (*System of Medicine*, Allbutt, vol. iii. p. 106), Still writes as follows: "Chronic fibrous rheumatism seems to be the best name for a third disease which has probably been indiscriminately included under the term rheumatoid arthritis in children. Its etiology and pathology are probably identical with those of acute rheumatism"; and in the article on Chronic Rheumatism in the same volume, Garrod, after referring to the difficulties of nomenclature and classification, states—

"We may group the cases to which the name of chronic rheumatism is more or less correctly applied under three heads as follows—

"(i.) Frequently recurring slight articular attacks, in rheumatic subjects.

"(ii.) Cases of chronic abarticular rheumatism, a condition best seen in children.

"(iii.) Joint lesions which persist after an attack or succession of attacks of acute or subacute rheumatism, and in some cases lead to permanent damage of the structures assailed."

These expressions of opinion taken collectively seem to harmonise with the teachings of clinical experience as to the etiological relationship between the different manifestations of rheumatic and rheumatoid disease in man, and they certainly lend colour to the suggestion that all these diseases may be due to the same cause or group of causes.

The known facts of bacteriology prove that acute rheumatism is of bacterial origin, but do not admit a final statement being made as to the single nature of the micro-organism. A good deal can be said in favour of Singer's view (p. 383) as to rheumatic fever being an attenuated pyæmia, and it is possible that the various subacute and chronic manifestations are susceptible of a similar explanation. Certain known facts lend some support to this opinion. Thus we find that Alexis Thomson, in the article on DISEASES OF BONES in vol. i. p. 539, writes as follows:—

"The marrow, especially in the interior of long bones during the period of active growth, is known to be one of the most favourable of soils for the lodgment of bacteria. The latter may persist in a condition of potential vitality for indefinite periods long after they have disappeared from the circulatory blood from which they were derived. The determination of disease in the bone resulting from bacterial lodgment in the marrow will depend, both as to time of onset, severity, and extent, on the initial virulence and number of the organisms, and upon the resistance of the tissues of the individual concerned, and upon the assistance of certain external conditions, *e.g.* trauma, strain, exposure, and cold, which will act also as localising factors in determining the seat and gravity of the disease." The same authority also refers to an attenuated form of staphylococcus osteo-myelitis, or growth fever (vol. i. p. 554), regarded by some as the explanation of "growing pains" in children and adolescents, and points out that definite changes have been found in the marrow in this disease.

The varying sites of incidence in the muscles, joints, heart, etc.—the different degrees of severity of the local manifestations—the presence or absence of febrile, and other general constitutional phenomena,—are probably all susceptible of explanation if we keep clearly in view the fact that no two people react alike to the same toxic agent. A study of the individual factor in disease is of paramount importance. And we must further keep in mind that the age of the patient probably influences that reaction materially, the tissues in childhood and early life reacting more strongly than at a later period. There is one point in the bacteriological aspect of the question that calls for reference. Investigations on the bacteriology of chronic rheumatoid arthritis have given uniform results only, in so far that great difficulty has been experienced in reproducing the disease in lower animals.

In this connection we must bear in mind the chronicity of the disease, and the possibility of attenuation of the bacteria at the diseased foci. The writer has lately examined the tissues of a horse seventeen years old, which had led a fairly active life for twelve years, during which time there had existed a small sinus in the groin, the result of sepsis at castration. Post-mortem examination showed widespread gross and microscopic lesions—the lesions in the kidney being very characteristic of a chronic pyæmia; but inoculation experiments carried out by an expert have not been successful in inducing any pathological lesions in lower animals, a fact which may be due to attenuation of the bacteria. This point is mentioned as worthy of consideration in connection with experimental research on chronic diseases in man.

With regard to the general causes of chronic rheumatism we need only refer to such conditions as exposure and cold, damp, the influence of a soil with a low-level water, and exposure to other infections, *e.g.* influenza. All of these are of a nature favouring bacterial invasion.

TREATMENT.—*Prophylactic.*—As the poison of rheumatism in its various subacute and chronic forms is one which specially selects the muscles and the soft and bony tissues entering into joint formations, the leading indication is to keep the tone of these structures, and especially the muscles, in as good a condition as possible. This sounds a truism, but as such it merits more attention than it generally receives. More attention to systematic physical education of youth is the basis of a rational prophylactic treatment. The value of this line of treatment is one which is readily demonstrable. There are many people who consider themselves in good health although they suffer from rheumatic pains and aches to a considerable extent. If these persons take a systematic course of exercises adapted to accelerate the circulation, and otherwise improve the tone of the muscles and nerves involved, in a very short time they will experience very marked relief from these manipulations—the permanence of the benefit being directly proportionate to the duration of the treatment.

This principle of prophylaxis is well illustrated in many continental health resorts where the English and other visitors take a course of treatment in one of the Zander institutes. This excellent plan could sometimes be followed by better results if the course were taken in a less haphazard fashion than is often done.

Curative.—For the curative treatment it is more advisable to lay stress on the principles which must guide us rather than to the means by which they are to be given effect to. If there is any breach of surface, *e.g.* cystitis, endometritis, and the like, special attention must be directed to that, as also to the state of the gastro-intestinal tract, and we must bear in mind that a considerable amount of disease may be present in the mucous membranes without revealing itself by any definite clinical symptoms.

(*a*) *Attention to the Excretory Organs.*—The intestinal function should be promoted by the administration of a laxative diet and judicious use of aperients. If the bowels move naturally every day all that is advisable is the administration of a small blue pill, followed by a morning saline once in ten days or so. If further treatment is indicated, as is usually the case, then the selection of a suitable aperient is the next point to be attended to. The best is perhaps the judicious combination of vegetable aperients, *e.g.* aloin, euonymin, with occasional saline. But in connection with these points we should remember that the constipation is more likely to be indirectly improved by the physical treatment later referred to. The aperients are merely adjuvants. In many cases there is marked fœtor of stools, a fact of considerable significance, calling for appropriate dietetic and medicinal treatment.

Renal Function.—The renal function is to be favoured by the patient drinking more fluid than is his wont. The best fluids are water and alkaline drinks. These are preferably taken on an empty stomach, the amount varying from about one pint more than his usual. We sometimes find that the patient never drinks anything except at meal hours, when the fluid taken is therapeutically not so beneficial as those just mentioned.

The skin function is best promoted by hydrotherapeutic measures, which must in every case be adapted to the strength of the patient. Above all, excess in this direction is to be avoided (see "BALNEOLOGY," vol. i.) For convenient use at home, one of the numerous bath cabinets now in vogue can be recommended; these require judgment and care in their use.

By the foregoing we may hope gradually to eliminate some, at least, of the toxic ingredients in the system in these cases, and we now pass to consider the means to be adopted in order to prevent further ingestion of substances likely to be injurious to the organism.

Physical Therapeutics.—Having discovered so far as possible what joints, muscles, tendons, or nerves are specially implicated, due attention must be paid to the affected parts. The different forms of manipulation and of action and passive exercises will be fully described in the section on "THERAPEUTICS" in a later volume. It must suffice here to indicate that this line of treatment is the one best adapted to effect the best result. One precaution is specially important. The practitioner must be fully satisfied that the assistant whom he employs for this purpose has had a really expert training in his profession, and not merely a few months' fragmentary education. Assistants of the latter type often do more harm than good, and their extensive employment is one of the reasons why treatment by manipulation, massage, etc., has not its due place in therapeutics.

Diet.—If the bowels are thoroughly attended to, many cases require no dietetic treatment, provided the diet taken is an ordinary one. In many cases the patient is aware that certain articles of diet affect the rheumatism unfavourably, and the use of such foods or drinks should be avoided or restricted. Nature is the best guide in these matters. Some rheumatic subjects keep themselves comparatively free by a vegetarian diet. Our present knowledge of the etiology of rheumatic affections does not allow of any hard and fast rules *re* diet. The following are suggested by clinical experience:—

(i.) The diet should be a simple one, taken at regular intervals and eaten slowly. When the digestion is good and the appetite strong, a large amount of food may be taken, provided it be of a simple nature.

(ii.) The articles of food and drink which patients consider detrimental to themselves should be withheld or given in sparing amount. Their nature may give a clue to the direction of faulty metabolism and assimilation. In this connection it is well to note the periodical nature of the symptoms, *e.g.* the recurrence of rheumatic symptoms at the fruit season.

(iii.) More fluid should be drunk. Most rheumatic subjects drink too little water. The writer lately saw a stout lady much affected with chronic rheumatism. Investigation elicited the fact that she never drank anything except a little tea twice or thrice daily, and a little whisky and water at night. The total urine was collected for three successive days, and was as follows:—8, 14, and 10 oz., of a non-albuminous urine of average sp. gr. 1015. The patient avowed that this was her usual habit, and it is probable that many rheumatic subjects suffer from this anuria in varying degrees.

(iv.) If the patient can furnish no indications as to diet, the best plan will be—(*a*) simplify the food by cutting off some of the unnecessary ingredients in the daily diet; and if that is insufficient, (*b*) restrict the carbohydrates, *e.g.* sweets of all kinds, potatoes, and other underground roots, and all puddings of a "stodgy" nature. A few cases may do better on a more strictly nitrogenous diet.

Medicinal Treatment.—Medicines are useful, but should occupy a subordinate place. A blue pill occasionally, with free use of alkaline and mineral waters, is a valuable line of treatment, which probably acts mainly by improving the conditions of the gastro-intestinal, hepatic, and renal functions. The old-time remedies of sulphur—internally and externally—and guaiacum are also very serviceable. Salol, salicylate of soda, and the like remedies are of service in some cases, and a judicious combination of these with other remedies, possessing some intestinal disinfectant action, are materially useful in some cases. The same can be said of the internal administration of iodide of potassium, and the internal and external use of various fir oils (see also "BALNEOLOGY," vol. i., and "GOUT," vol. iv.)

Rhinitis. *See* NOSE.

Rhinorrhœa. *See* NOSE.

Ribs. *See* CHEST, INJURIES OF; and FRACTURES.

Rickets.

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DEFINITION.—Rickets is a chronic disease of early life, in which the chief anatomical changes consist in enlargement of the epiphyses and deformities of the bones, while the ligaments, muscles, and many of the internal organs are also apt to be affected.

ETIOLOGY AND PATHOLOGY.—Rickets in its most typical form occurs between the ages of six months and two years; but the early symptoms are often noted during the latter months of the first half-year; while the results of rickets—in the shape of stunted and deformed limbs—are seen long after the age of two years has been passed. A peculiar form of rickets is sometimes seen in older children and young adults (late rickets).

Rickets is an exceedingly common disease in the large cities of the United Kingdom, as well as in the industrial centres of Europe and North America; it is comparatively rare among the natives of semi-tropical countries such as India, China, and Japan. It is much less common in country districts than in cities, as for instance in a Westmoreland village, where the inhabitants are a sturdy race of farmers and follow outdoor pursuits, than in a Lancashire village or city, where the inhabitants are miners or factory operatives. It is common among a population given to early and improvident marriages, and where in consequence over-crowding and poverty exist, while the infants are artificially fed on account of the mothers going to work in the mills. It is rare among a population where the parents are thrifty and sturdy, and suckle their infants for the greater part of the first year.

The chief predisposing causes of rickets are (1) congenital weakness, (2) unhealthy life conditions, and (3) improper feeding and dyspepsia. Rickets is not a hereditary disease in the sense that rickety parents transmit the disease to their offspring, but there can be no doubt that infants of weakly parents more often suffer from rickets than the infants of robust parents. Unhealthy life conditions undoubtedly predispose to rickets. Among these conditions must be mentioned the influence of a cold and damp climate in producing bronchial and intestinal catarrhs, the continuous breathing of vitiated air in crowded dwellings, the neglect of cleanliness so common among the poor. Life in the crowded dwellings of the poor predisposes to indigestion, while fresh air and sunlight are powerful factors in promoting digestion and tissue-building.

There can be little doubt that bad feeding and chronic dyspepsia are the most efficient predisposing causes of rickets. Vigorous infants nursed at the breasts of healthy mothers rarely suffer from rickets while being suckled, even though exposed to the life conditions incident to a crowded court. It is the artificially fed infant that suffers, whether fed on condensed milk, starchy foods, or fresh milk. We find for the most part that children who have well-marked rickety deformities have suffered much from indigestion, have been difficult to feed, though many changes of food have been tried, while in some there is a history of long-continued bronchial catarrh. On the other hand, it must be admitted that in some mild cases there has been no obvious indigestion, the surroundings have been all that could be desired, and the feeding carried out with care. It must also be said that bad feeding and continuous indigestion do not always produce rickets; there may be ill health and wasting in an infant without any of the characteristic signs of rickets. This is also true of experiments on animals,—bad feeding and insanitary conditions will produce ill health in puppies and other young animals, but very rarely rickets (Spillman).

If, as stated, it is extremely probable that chronic indigestion plays an important part in predisposing to rickets, yet we are in much ignorance concerning the immediate or exciting cause. Some writers (Heitzman, Monti) have laid great stress on the lactic acid fermentation which takes place in chronic dyspepsia; they aver that in consequence of a deficiency of HCl in the gastric juice there is an imperfect solution of lime salts and also an excessive formation of lactic acid, large quantities are absorbed into the blood, and this lactic acid poisoning is the efficient and immediate cause of rickets. It has also been suggested that rickets is due to an imperfect oxidation of the blood in the lungs, in consequence of the bronchial catarrh so often present, and collapse of lungs in connection with the misshapen chest. It is quite safe, however, to say that neither of these hypotheses go very far in explaining the causation of rickets.

The trend of modern opinion is rather in the direction of seeing in rickets the results of the absorption of toxines from the alimentary canal, which are formed during a period of chronic indigestion. The sweating, the muscular paresis, the laryngismus and convulsions, suggest the presence of toxines in the blood, which have been formed in the alimentary canal from the maldigestion of the proteids, fats, or starches in the food. It is very possible that several allied toxines may be formed which give rise to special symptoms. Thus in some cases the bone changes are most in evidence, in others the muscular system chiefly suffers. In other cases convulsions, tetany, and laryngismus are present, while in others they are absent from first to last. Thus it would seem likely that rickets is the result of a peculiar form of chronic dyspepsia, in which certain toxines are formed from bacterial action, and it is the passage of these toxines into the blood from the alimentary canal that gives rise to the pathological changes which take place in this disease.

Clinical Features and Course.—The early symptoms of rickets do not always include well-marked deformities or any evidence of softening of the bones. Before these changes occur there is a period during which the symptoms are rather those of subacute or chronic indigestion, with great irritability and night sweats. These early dyspeptic symptoms include flatulence, constipation, foul-smelling stools, restlessness and wakefulness at night, sweating followed by plentiful crops of miliaria, very possibly there may be convulsions. Such symptoms may be noted as early as the fourth or fifth month, but oftener, perhaps, not till a few months later. The infant is usually a notoriously bad sleeper, it keeps its mother or nurse awake for hours together because it cannot rest, and when it does dose its sleep is broken, and beads of perspiration appear on its forehead and scalp, while its skin and night clothes become damp and clammy. The miliaria with which the body becomes covered is probably attributed by its nurse to "teething." It is very apt to continually rub the back of its head against the pillow, with the result that the hair is worn off at this spot.

The marked restlessness which is often such a marked feature in early rickets is no doubt due to the flatulence and distension so often present, but very probably also the bones may ache or be more or less tender. When the bones are acutely tender an associated scurvy is almost certainly present.

If these symptoms persist for many weeks or months some evidence of rickety changes in the bones and muscular paresis is sure to be present. Perhaps the occipital and parietal bones will be abnormally thin, and readily yield to the pressure of the finger (cranio-tabes), and the former may become more or less flattened from pressure of the head on the pillow when lying on the back. Or the eminences of the frontal and parietal bones begin to appear unduly prominent, giving the infant's head a heavy, square look. An examination of the chest may show that the chest wall is being sucked in on each side of the sternum during inspiration in consequence of a want of rigidity of the ribs and their cartilages; the swellings at the junction of the ribs and cartilages may be exaggerated. All these signs may be noted before six months of age, but they are, perhaps, more usually noted somewhat later.

The infant may in this early stage be subject to convulsions without any very obvious cause, and also laryngismus and tetany may occur, but the two latter are more common during the second year. In spite of its evident ill health the infant probably does not waste to any extent, and may be very well nourished as far as fat is concerned. Some infants at this period suffer much from bronchial catarrh, and they very easily "catch cold." The muscular system is almost certain to be weak, and the infant is late in learning to hold up its head or in attempting to sit up. The urine has often a peculiar strong smell likened by some to trimethylamine.

The course of the disease if not checked by treatment is essentially chronic. As time goes on no teeth make their appearance at the usual time, the head becomes more markedly square, the chest more deformed, the epiphyses at the wrists and ankles enlarge, the infant cannot sit up, and perhaps cannot hold up its head. At the end of the first year, if the case is severe, the child presents a typical picture. The head is large and square, and out of proportion as compared with the stunted limbs, the chest is narrow and deformed, the abdomen is large and round from the presence of gas in the stomach and intestines, and in some cases an enlarged liver and spleen can be felt. The rickety rosary can be seen or felt, and the epiphyses at the wrist and ankle are very prominent. The child cannot sit up without help, and is quite helpless as regards crawling or standing alone; its ligaments are weak, and its muscles very poorly developed. It is perhaps anæmic, in some cases markedly so.

During the second year the most characteristic feature consists in the curvatures of the long bones. The child uses its limbs more or less at this period, and there is therefore a greater danger of their bending than earlier. When the child sits up in bed or on the floor it rests a certain amount of weight on its arms, and a curvature with the convexity outwards perhaps takes place in the bones of the arm and forearm. But the lower ends of the tibia and fibula are more likely to bend than the arms, when the child sits on the floor with its legs crossed or doubled under it; the bones perhaps bend with a sharp curve inwards in their lower third. If the child sits up, either by itself or is propped up, the spinal column is very likely to give way, the whole length of the spine bowing backward (kyphosis). The digestion is probably very poor, it cannot digest well, especially the curd of milk, and its stools are pasty and foul smelling. At this time laryngismus is common, and so also is a persistent bronchial catarrh, which returns again and again.

The child may remain more or less in this state during the whole of the second year. The teeth appear slowly; it is very slow in making progress in crawling or in attempting to stand alone. The limbs remain more or less stunted, the muscles soft and flabby, the joints loose from laxity of the ligaments. The child is probably late in learning to understand or talk, and is backward in mental development. It may perhaps learn to stand alone during the third year, or there may be still further delay. It is after that it has learned to get about on its legs that the knees give way and knock-knees appear. Some children remain for years making but little advance and being practically bedridden. Others are able to get about with a waddling gait in consequence of knock-knees and perhaps coxa vara; they are stunted in body and backward in intelligence.

It is hardly necessary to say that the above description applies only to a severe case, and the combination of signs and symptoms may differ. It may happen the rickets may be fairly severe, and yet the head is of a normal shape, while the deformity of the chest is considerable. Or the epiphyses of the wrists may be normal, the chest fairly well formed, but the muscles are flabby and the joints loose, so that at two years old the child is not walking, and very likely not talking. In some others laryngismus may be very severe, and but slight curvatures or deformities of the bones present.

In other cases, again, the infant is abnormally pale and fat, the muscles are flabby and weak, and there are no marked departures from normal as far as the bones are concerned.

Having sketched the course of the disease, a more detailed description of some of the more important signs and symptoms may now be given.

Head—Cranio-tabes—Natiform Skull.—It is not uncommon to find in examining the heads of infants, especially those who are wasting or not doing well, that in places, or all over generally, the occipital and parietal bones are abnormally thin, and can be pressed or bent in by pressure of the fingers. In examining an infant's head in this way it is well to avoid the sutures and posterior fontanelle, as the most characteristic patches of atrophy are usually nearer the centres of the bones. The whole of these bones may be abnormally thin from defective calcification, or there may be small patches scattered about which consist simply of membrane. Cranio-tabes was described as being a sign peculiar to rickets by Elsasser many years ago. Since his time it has been attributed to syphilis by Parrot and others. There is no doubt that it occurs in rickets, but it is not pathognomonic, as it occurs not uncommonly in cases of malnutrition which are not rickety. It is doubtful if its connection with syphilis is anything more than a casual connection, though this is not the universal opinion. It has already been noted that at times the ossification of the occipital bone is so defective, that it becomes flattened in by the pressure exerted by the weight of the head resting on the pillow. Elsasser took an exaggerated view of the importance of cranio-tabes, and attributed some of the nervous symptoms occurring in rickets, as laryngismus, to the thinning of the bone, but this is very doubtful. While cranio-tabes is not pathognomonic, in all cases of marked thinning of the occipital or parietal bones rickets should be suspected. More certainly characteristic of rickets is the square head and the natiform skull. The former is much the more common, and may often be noted before the infant is six months old. It is the result of an excessive formation of spongy bone at the centres of ossification of the frontal and parietal bones. The result is a flattening of the superior surface, a certain squareness in appearance as well as an increase in the circumference of the head. The edges of the bones bordering on the fontanelles can be felt to be thickened, though perhaps abnormally soft, and the fontanelles are widely open for the age of the infant. The natiform skull is often present in severe rickets, and indeed only appears in severe cases. There are two broad grooves on the top of the head corresponding with the longitudinal and transverse sutures, and therefore at right angles to one another, giving the upper surface of the skull a sort of "cross bun" appearance, while the four quarters of the upper surface are raised as bosses (Parrot's bosses). The edges of the bones forming the grooves are mostly membranous, and often cranio-tabes is present. Many believe the natiform skull is a sign of syphilis (Carpenter).

Dentition is mostly delayed, and the appearance of the teeth through the gums may be out of their usual order. In some cases the two lower central incisors may appear at the normal time, then rickets may supervene, and there is a long delay before others show themselves. In some cases of rickets the milk teeth quickly become carious, but this is not constant. The fontanelles are slow in closing, and the edges of the bones which form their borders are apt to be thickened and softened from deficient calcification. The fontanelles may be found widely open at two years old, or indeed at times as late as four years old; whenever there appears a delay in these openings closing up, rickets may be suspected.

Chest.—In marked contrast to the large head and rounded abdomen of rickets the chest is narrow and constricted. At the junction of the ribs with their cartilages, especially the fourth to the ninth, there are enlargements which form a row of prominences, the so-called rickety rosary. Both ribs and cartilages lose their rigidity in a more or less marked degree, and as a result of this, part of the chest wall is sucked in during inspiration, and shallow, broad grooves are formed on both sides of the sternum; the latter is more or less thrust forward, and thus the so-called "pigeon" chest is formed. The typical rickety chest, however, is not the true "pigeon chest"; in the rickety chest the sternum and cartilages are thrust forward from falling in of the ribs, and the protuberance is rounded. The pigeon chest with the keel-like ridge is due to softening of the cartilages in later childhood. In other cases the groove is horizontal and corresponds with the attachment of the diaphragm, the chest wall is pulled inwards, and the lower edge of the chest wall everted. This groove is sometimes known as Harrison's sulcus. Should the infant suffer from bronchitis the chest deformity will tend to become aggravated, and it is certain that the deformity and want of rigidity of the chest wall greatly adds to the danger of an attack of severe bronchitis or broncho-pneumonia. As the child gets older the chest deformity tends to become less marked, the ribs become more firm, but usually more or less deformity remains for life.

Limbs.—The deformities of the bones of the limbs mostly occur at a later date than those of the head and chest. They consist for the most part of an exaggeration of the normal curves, and they are brought about by the child using its limbs for some purpose or other such as locomotion. The commonest is a curving inwards of the tibia and fibula in their lower thirds, and this is most commonly produced by the child sitting up in bed or on the floor with its knees flexed and perhaps the feet crossed. Almost any movement of the feet in raising itself or in progression will tend to curve the tibiæ inwards. If the child habitually supports itself in the sitting position with its arms, both the bones of the arm and forearm will tend to be bent with the convexities outwards. The curve assumed by the femur is mostly forwards and outwards, bending of the neck of the femur is also apt to take place (coxa vara), (see DEFORMITIES, vol. ii. p. 431). Enlargement of the epiphyses of the long bones is sometimes very noteworthy, especially at the wrists and ankles. Irregular outgrowths of bone are apt to take place in various places, as, for instance, the rickety tubercle often present on the inner side of the head of the tibia, and the outgrowth of the inner condyle of the femur in knock-knee.

Muscles and Ligaments.—The malnutrition and weakness of the muscles is as constantly present in rickets as the deformities and softening of the bones. The voluntary muscles are all poorly developed, so that perhaps at a year old, or even later, the infant makes no attempt at sitting up or even holding up its head. For long after it can sit up in a sort of fashion, its back is likely to be weak on account of the laxity of the ligaments and the erector spinæ group of muscles. There is usually a general bowing backwards of the spine, the natural curves being lost in the general bend. By the end of the second year the child may have made no progress in crawling, or walking, or standing. In other children who have managed to get on their legs the stretching of the ligaments plays an important part in the production of knock-knees, flat feet, and later curvatures of the spine.

COMPLICATIONS AND ASSOCIATED CONDITIONS. — Rickets is often associated with various conditions, and it is difficult to say if they are an integral part of the disease or complications.

Bronchitis and Broncho-pneumonia.—Many rickety infants suffer a good deal from bronchial catarrh, they seem exceedingly sensitive to cold, and in consequence are kept indoors in an over-heated, badly-ventilated room for months together. Sometimes the bronchitis is associated with laryngismus. There can be no doubt, also, that infants who suffer much from bronchial catarrh, and are kept in the house and deprived of fresh air, develop severe rickets. The deformity and want of rigidity of the ribs, as well as the weakness of the muscles of respiration, predispose to these catarrhs. Broncho-pneumonia is apt to be very fatal in rickety children.

Gastro-intestinal Catarrh.—The enlarged rounded abdomen is always present in a well-marked case of rickets. There is a constant formation of gas in the stomach and bowels in consequence of the fermentation of the food, while the muscular coat of the intestines is poorly developed and toneless; this tends to the stagnation of the imprisoned gas. In some cases, at least, the stomach is also dilated and constantly distended. Constipation, which is so common in rickets, is due also to the toneless state of the muscular coat of the intestines. Chronic indigestion is very commonly present as an early symptom, and is mostly present during the first two years or more. Through the whole course of rickets the digestion is weak, and the stools apt to be pale in colour and fœtid.

Scurvy.—Rickets and scurvy are frequently associated with one another. In severe cases of rickets there is frequently a certain amount of tenderness of the bones and perhaps no other sign of scurvy. All degrees of scurvy may be present in a bad case of rickets (see "SCURVY").

Syphilis.—Since the days when Parrot asserted that congenital syphilis was the real cause of rickets, there has been a good deal of difference of opinion as to the part syphilis has played as a complication of rickets, if certain signs and symptoms often seen in cases of rickets were to be regarded as due to syphilis or not. No one now believes that syphilis has anything to do with the causation of the majority of cases of rickets, but there is some difference of opinion as to whether the natiform skull, craniotabes, anæmia with enlarged spleen, etc., should be regarded as signs of syphilis or not. While the subject cannot be looked upon as settled, it is certain that both the natiform skull and anæmia with enlarged spleen are associated with marked deformity of the bones in the immense majority of cases. It is clear, however, that syphilitic children often become rickety.

Anæmia and enlarged Spleen.—In many cases of rickets there is no anæmia, and indeed children with rosy faces may be seen who are unable to stand alone, and have bent legs and deformed chests. An enlarged spleen is by no means constant in rickets, but in the earlier stages of rickets and in a severe case there is often marked anæmia, and at the same time there is, perhaps, also an enlarged spleen to be felt some few fingers' breadth or more below the ribs. Marked rickets, striking pallor, and a spleen reaching two or three inches or more below the edge of the ribs, form a not uncommon combination of symptoms in children, especially during the second year. These cases, when well marked, have been described as "splenic anæmia" or "pseudo-leukæmia infantum," but according to the writer's experience the signs of rickets are almost constantly present. The natiform skull, the rickety rosary, and enlarged epiphyses are commonly seen. It is not possible to say in these cases if rickets is the primary disease, and the splenic anæmia secondary and dependent on the rickets; certainly, as regards time of onset, rickets often comes first. It has been suggested that these cases are a combination of rickets and syphilis, but a history of syphilis is often absent, while the signs of rickets are almost universally present. An examination of the blood in these cases shows a diminution of the number of the red corpuscles (2,000,000 to 3,000,000 per cm.) and an increased number of leucocytes (25,000 to 30,000 per cm.), also many nucleated red corpuscles. There seems to be no constact departure from the normal with regard to the different leucocytes present. These cases are essentially chronic, but usually improve under treatment, the spleen diminishing in size and the number of blood corpuscles increasing. If death takes place it is usually through some complication, as measles or pneumonia. The writer has seen several of these cases, when four and five years of age, with more or less rickety deformity remaining, the spleen still to be felt well below the ribs, and some slight anæmia. Apart from the cases just referred to, in which there is a very noteworthy hypertrophy of the spleen, most authors agree that there is a more or less enlargement of the spleen during the course of some cases of rickets, but that this enlargement is not constant. Cohn found the spleen enlarged 58 times in a clinical examination of 858 rickety children. Kuttner noted enlargement in 44 out of 60 cases of rickets; in 33 of these the edge of the spleen could be felt under the border of the ribs, in 9 cases the edge came two fingers' breadth below the ribs, and in 2 the hypertrophy was very considerable. There is no agreement among authors as to whether the hypertrophy of the spleen is an essential part of the disease, or whether it is secondary to some complication so often found in association with rickets. Whatever view may be taken of the slighter enlargements, there can be no doubt that when a well-marked anæmia is present it is constantly associated with splenic enlargement.

Skin.—The profuse sweats so common in rickets are apt to give rise to crops of malaria or intertrigo in the folds of the neck and groins, and perhaps troublesome boils. Eczema of the face and scalp is also apt to be very troublesome in a rickety infant. During sleep the sweatings aggravate the eczema, and much weeping is the result. The exudation cakes and scabs as it dries up. In such cases convulsions, high temperature, and sudden death may take place.

Nervous System.—Rickety children are apt to be backward in intelligence, being late in learning to talk as well as in learning to walk. They are apt to be lethargic and apathetic, and disinclined to exertion of any sort. Rickets certainly predisposes to convulsions; these may come on as early as the fourth or fifth month, or at any time during the first or second year (see "CONVULSIONS"), see also ("LARYNGISMUS" and "TETANY").

Fractures.—Rickety bones are apt to break as well as bend; the fractures are usually of the "green stick" variety, *i.e.* the fractured ends are held together by the thickened periosteum, usually at a more or less acute angle. The ribs may kink at or near their angles, the fractures involving four or five or more of the middle ribs. Fractures of the middle third of the humerus may occur when the child is lifted by its arms, the tibia is apt to kink at the usual seat of bending in the lower third. Fractures of the femur, clavicles, and bones of the forearm are not uncommon. In some of the cases of fracture scurvy may be present. Separation of the epiphyses may take place under similar circumstances.

MORBID ANATOMY.—In the healthy infant of four or five months of age the shafts of the long bones are completely ossified, while the epiphyses, with one exception, consist entirely of cartilage. The bones grow in length by ossification taking place between the epiphysis and shaft, and in girth by the formation of compact bone beneath the inner layers of the periosteum. The bones of the skull are also fully ossified at this time with the exception of the edges where they form the fontanelles. It is at this period, or somewhat later, that rickets is liable to supervene, and a pathological process succeeds the normal physiological process of bone formation.

In making a post-mortem of a case of severe rickets, the deformed chest, bent ribs, with rows of prominences or "beads" at their junction with their cartilages, will at once strike the attention. The "beads" will be seen to be as marked or more so on the pleural as on the cutaneous side. On removing a rib it will be found that it is easily bent or kinked, and that it has lost most of its normal rigidity and elasticity; the periosteum is thick, so that when the bone is broken between the fingers the two ends are held together by the external fibrous tissue. If a longitudinal section be made by a knife through the swollen anterior end it will be seen that the greater part of the swelling involves the cartilage (the columnar zone), while the epiphysial line which marks the boundary between bone and cartilage is deeper and much more irregular than in healthy bone. A transverse section of the rib itself shows an almost complete absence of compact tissue; only spongy bone is seen, and much red grumous material. An examination of the radius will probably show similar changes; the bone can be bent or broken between the fingers, and section through the epiphysis will show swollen cartilage and a broad, irregular epiphysial line. The bones of the vault of the skull are abnormally soft, can be easily doubled up between the fingers, and cut with a knife. The ossifying centres, *i.e.* the parietal and frontal eminences, are thickened, and on cutting into them they show much soft, spongy tissue; the edges of the bones are thick and soft. Instead of or in addition to the thickening just referred to there may be atrophic changes; the parietal and occipital bones, when stripped of their dura mater and held up to the light, are seen to be thin and transparent in places, where calcareous matter has been absorbed and left membrane only. Rickety skulls are apt to be large ones, at least in their circumference, on account of the exaggerated condition of the frontal and parietal eminences; their internal capacity, also, is at times apparently increased, as the brain is sometimes of abnormal size. There is no association between rickets and hydrocephalus, though children suffering from chronic hydrocephalus may become rickety.

Summarising the changes produced by rickets, it may be said that rickety bones in their early stages are characterised by swelling of the epiphyses, thickening of the periosteum, decrease of lime salts, increase of the red gelatinous medullary material, with the result that the bones are softened, fragile, and stunted in growth.

If death take place at a somewhat later period the bones will be found more or less curved or bent, and possibly evidence of fractures will be present. In a later stage the bones will be found firmly consolidated, often presenting an ebony-like hardness.

The exact nature of the bone changes in rickets, whether inflammatory or not, remains for the present undecided. It is tolerably certain, however, that these changes are not primary, but that they are secondary to some general disease. If a section be made through the beaded end of a rickety rib, and an examination be made under a low power, it will be seen that the swollen end corresponds with the lower zone of cartilage in which the cartilage cells have undergone proliferation, and are arranged in columns. It is clear that an abnormal amount of proliferation has gone on, that the matrix has undergone softening, and there is a bulging which corresponds to this columnar zone. Next to and beneath this zone is the epiphysial layer—which normally is narrow and sharply defined—in which the provisional calcification is proceeding by the deposit of earthy salts in the matrix of the cartilage; beneath this again is the zone where true bone is being formed through the medium of the osteoblasts and blood-vessels. In a case of severe rickets this epiphysial line is very irregular, and is made up of irregular areas of uncalcified cartilage belonging to the columnar zone, patches of calcified cartilage, and osteoid tissue in which no calcification has taken place, with also medullary spaces and blood-vessels. It will be seen that the preparation for ossification is excessive and much beyond the normal, but in spite of a sufficiency of lime salts very little calcification takes place. For some reason the cartilage matrix and the oseteoid tissue are unfit for the deposition of lime salts; the formation of true bone is retarded, and the net result is fragile and soft, cancellous tissue with large spaces filled with red gelatinous material. Beneath the periosteum there is also an excessive amount of cell formation, while calcification is retarded, and instead of compact tissue a spongy mass is formed.

In connection with the changes which occur in the bones in true rickets, it is interesting to compare the changes noted in the bones of young animals fed on foods poor in lime salts, and in which a sort of pseudo-rickets takes place. Stoeltzner fed a six weeks' old puppy on raw horse flesh, bacon, and distilled water, a food poor in lime salts. The animal gained in size and weight during the research, which lasted eight weeks.

Ten days after the commencement of the experiment the bones appeared to be tender, there was some swelling of the epiphyses, beading of ribs, and bending of the long bones of the limbs. An examination of the bones at the section showed swelling of the ends of the ribs corresponding to the columnar zone of the cartilage, some thickening of the periosteum, and a high degree of osteo-porosis that at first sight appeared identical with rickets. A careful examination showed that this osteo-porosis differed essentially from rickets, in that in rickets an excessive preparation for ossification took place, viz. a rich formation of osteoid tissue which, however, remained almost uncalcified, while in osteo-porosis but slight preparation much less than normal took place, and in spite of the scarcity of lime salts this little was calcified. Also in osteo-porosis in opposition to rickets, the cartilage matrix in spite of the insufficiency of lime salts became calcified.

Visceral Lesions.—Various lesions are apt to be found post-mortem in children who have suffered from rickets, but for the most part they are complications rather than integral parts of the disease. Thus bronchitis, broncho-pneumonia, collapse of lung, and emphysema may be present, and have brought about the fatal result. Catarrh of the stomach and intestines is frequent, and a considerable degree of dilatation of the stomach and also of the large bowel may be noted. Huguenin observed a dilated stomach in an infant suffering from severe rickets, and who died of broncho-pneumonia at the age of ten months, which reached nearly to the umbilicus, and Baginsky has related a similar case. The liver also is often notably enlarged, and in some cases fatty.

Reference has already been made to the frequent enlargement of the spleen in rickets. Stark found the spleen enlarged in fifty-three cases out of ninety-three post-mortems on children suffering from rickets, who had died of broncho-pneumonia, gastro-intestinal catarrh, pleurisy, or anæmia. He found no macro- or microscopic changes in the organ peculiar to rickets, and he believes that the enlargement is due to complications present. Sasuchin, on the other hand, who has recently examined twelve hypertrophied spleens present in rickety children, believes the changes he found to be characteristic of rickets. The largest spleen he examined weighed 51·2 grammes (normal weight 20·4), from a child of twenty months who died of broncho-pneumonia; there were marked changes in the bones, including enlarged epiphyses and genu valgum. The changes found in all the spleens examined suggested chronic inflammation, thickening of the capsule and trabeculæ, atrophy of the Malpighian bodies, and narrowing of the arteries. He made control examinations of spleens of children dying of broncho-pneumonia, etc., without rickets, and failed to find these changes.

Fœtal Rickets.—It may be said with certainty that many of the cases which in times past have been reported as cases of fœtal rickets had very little in common with true rickets. Parrot first separated achrondoplasia from the intra-uterine bone lesions due to other causes. In achondroplasia or chondro-dystrophia fœtalis the bones of the extremities are extremely stunted and bent, while the bones forming the vault of the skull and also the chest are fairly well developed (see "Achondroplasia"). Stœltzner has recently reported a case of "fœtal myxœdema," in which the limbs were bent and stunted, while there was some enlargement of the epiphyses, but in general the case far more closely resembled achondroplasia than rickets. After excluding the above conditions there remain a large number of observations on congenital bone disease which vary considerably, and probably own a variety of causes. Most will be inclined to agree with Ballantyne when he says of this class, "We have not yet reached a time when a scientific classification founded on pathological lines is possible."

The class of cases which most resemble rickets are those in which fractures occur during birth or shortly afterwards, and in which there is cranio-tabes, misshapen chest walls, and less often curvatures and enlarged epiphyses. Such cases have been published by Osgood Mason, Townsend, H. Ashby, and others. They all agree in that the infants were born with imperfectly calcified bones, especially of the skull, ribs, and bones of the limbs, fractures readily took place, and in some reported cases the bones were bent and the epiphyses were enlarged. Were they cases of true intra-uterine rickets? Certainly they have a close resemblance clinically, but, on the other hand, it seems not unlikely they more closely resemble the osteo-porosis or osteo-genesis imperfecta produced by feeding puppies and other young animals on food deficient in lime rather than true rickets. More observations are needed in examining the bones of fatal cases by modern methods before their true nature can be definitely stated.

Late Rickets.—While rickets in its typical form only occurs during the first two or three years of life, yet during the whole time growth and development are in progress some of the signs and symptoms of rickets may make their appearance. After the epiphyses have become ossified and joined to the shafts it is hardly possible for rickety deformities to occur. The symptoms of "late rickets," which usually supervene before puberty, consist in perspirations, fatigue on slight exertion, gradual enlargement of the epiphyses of the long bones, especially marked at the knees and ankles, weakness of muscles, laxity of ligaments, producing various deformities, such as lateral curvature of the spine, knock-knees, and flat feet. Enlargement of the head, curvatures of the long bones, deformity of chest belong rather to the period of early than late rickets, yet in exceptional cases they may occur. Many of these cases are probably relapsed rickets. In severe cases the child or young adult is reduced to a complete invalid, and often more or less of a hypochondriac. He is tired at the least exertion, complains of pains in the bones, is very nervous and irritable, and has to lie up nearly the whole of the day. Such cases may remain for years in the same condition. If the patient is a boy he is unfit for school, and probably loses many years of his school life. The subjects of late rickets are frequently lanky, overgrown boys or girls.

While the above description applies to a fairly common type of case met with during late childhood or early adult life, in rare cases the disease which thus commences late is much more severe, and the deformities of the bones much more resemble the type of rickets seen during the second year. In some of these patients there is a history of having suffered more or less from rickets at the usual period; they have apparently got well and remained so, perhaps, for some years, and then there has been a relapse. In other cases there is no such history, there has never been any bone deformity till at or after puberty; it is noticed that they begin to have a waddling gait, the legs begin to bend, there is a very marked enlargement of the epiphyses of the bones forming the ankles, knees, wrists, and perhaps the elbows and shoulders. These deformities may be accompanied by pains and achings in the bones. Beading of the ribs may occur. In some cases deformities of the chest have been observed, and in one rare and remarkable case published by James, in which the disease began in a youth of seventeen years, the skull enlarged in addition to the other deformities described. In one case recorded by Clutton, a post-mortem examination confirmed the diagnosis of late rickets made during life.

Diagnosis.—There cannot be any difficulty in recognising a case of rickets in a child under two years of age if the usual symptoms and signs, such as sweating, deformities of bones, muscular weakness, etc., are present. There may be uncertainty in the early months when there is only sweating, or indigestion, or convulsions; and later on, when rickets is present, the difficulty may arise in deciding how far some of the symptoms present are due to rickets or to some other cause. Thus a rickety child of three or four years old may suffer from fits. Are these fits epileptic, or are they the result of the rickets? In some cases the muscular weakness is so great in rickets that it is apt to be mistaken for paraplegia. When the rickety child is just able to walk, his waddling gait and difficulty in rising from the floor will perhaps suggest pseudo-hypertrophic paralysis.

As already pointed out, the difficulty of determining whether in a given case the infant is suffering from hereditary syphilis and has become rickety, or whether the signs and symptoms present are due to rickets alone, is very great. Thus an infant of five months old suffers from eclampsia, coryza, anæmia, has a natiform skull and beaded ribs. There is no history of rash or of syphilis. The spleen is enlarged. Are the natiform skull and enlarged spleen due to syphilis or rickets?

Prognosis.—Rickets *per se* is never fatal, but the presence of severe rickets immensely adds to the danger of an attack of bronchitis or broncho-pneumonia. Both measles and whooping-cough are very fatal in rickety children under two years of age. The loss of rigidity in the chest walls and the consequent sucking in of the ribs during inspiration prevents the clearing of the bronchi by coughing, and tends to passive congestion of the lungs. Sudden death may at any moment occur in a child with severe rickets and laryngismus; the writer has made several post-mortem examinations on children with marked rickets, who died suddenly from asphyxia, the result apparently of spasm of the glottis, who had never been heard to "crow" or known to have suffered from attacks of respiratory spasm.

Apart from complications rickets tends to get well. The bones harden, and in cases of slight deformity tend to regain their normal shape. The more marked deformities may be life-long.

Treatment.—If, as alleged, unhealthy life conditions, improper food, and chronic dyspepsia play an important part in the causation of rickets, it is evident that the general principles of treatment must be to place the infant or child under the most favourable hygienic conditions, and to supply it with a "living" food which it can digest and assimilate.

To remove the infant from city to country or seaside, where it will have an abundance of fresh air and sunlight, will be a wise procedure if circumstances permit; in any case arrangements must be made to give the infant as much fresh air as possible, though on account of the tendency so many rickety infants have to bronchial catarrh the daily outing is a time of some anxiety. No rickety infant, though suffering from bronchitis, will flourish or improve if confined to a close and ill-ventilated room, where a steam kettle is sending forth volumes of steam and saturating the atmosphere with moisture. If the infant is confined to the house, wherever it is possible two rooms should be reserved for it, the unused room being flushed with fresh air while the other is being occupied. Whenever the weather permits the child should spend the greater part of the day in the open air. Care should be taken with its clothing: Shetland wool vests, abdominal belts with drawers of the same material, form light and warm articles of clothing.

The most important matter in connection with the treatment of rickets is the question of food. It is useless to prescribe a theoretically correct food if the child cannot digest it; it is no use ordering large quantities of fresh milk if the infant is passing white, curdy, stinking stools; it is probably already taking more than it can digest, and to add more means an addition to an already overburdened digestive apparatus, and a still greater amount of proteid-toxine poisoning. If the infant is seen in the early stages for the first time, the first step will be to secure an effective evacuation of the decomposing contents of the bowel, and to supply a food that the child can digest. Thus an infant of eight or nine months of age is sweating and restless, there is chronic dyspepsia, the ribs are beaded, the stools white and dry. It is certain that in such a case the gastric, intestinal, and biliary secretions are weak, milk curd is badly digested, and the whole digestive apparatus is overtaxed. While fresh milk in any quantity is not well borne, yet thick foods, starchy foods, condensed milk, dried milk foods, pancreatised food, are out of court, or at any rate should not be used except as temporary resorts. If pancreatised food is used at all it should not be given at every meal, and the digesting process should not be carried too far. It is well to begin with a thin food to test the infant's powers of digestion, such for instance as whey (see vol. i. p. 408), given in quantities of say 30 oz. with $\frac{1}{2}$ oz. of sugar of milk in the twenty-four hours. If the stools appear more healthy, the amount and strength of the food may be increased by the addition of milk or cream; 5 to 10 oz. milk may be added to the 30 oz. of whey after the latter has been scalded. An ounce of milk sugar may be added. Instead of the milk a weak cream (made by standing a quart of milk in a glass jar for five or six hours and taking the upper 10 ounces) may be used, but the stools must be carefully watched while the food is being made stronger, and any sign of indigestion is a signal to reduce the strength. Weekly weighings are advisable, remembering, however, rickety children may put on fat without being any better as far as their rickets is concerned.

It often happens that these infants cannot digest any quantity of milk, and as soon as the latter is pushed they fall back into their old dyspeptic state. In such cases raw beef juice or plasmon or somatose may be added to the whey instead of milk. In some cases, at least, small quantities of oatmeal or finely ground whole meal flour may be given with the food. The constipation is often very troublesome, yet it is important to secure a daily evacuation; for this purpose a few grains of carbonate of magnesia may be added to each bottle of food, or syrup cascara aromat. may be given in 5 to 15 drop doses three times a day, and continued for weeks together if necessary. Given in small and repeated doses, and perseveringly used, this drug is usually very efficacious in sluggish conditions of the large bowels.

Orange juice should be given daily, especially if the proportion of milk taken is comparatively small.

During the second year we have a greater variety of foods at our disposal, such for instance as eggs, scraped raw beef, marrow of bone, chicken, and beef tea, as well as cream and whey, light puddings, and thin gruel. It is very possible that the rickety child at this age will digest milk badly, and the tendency of nurses is to give more than it can digest, or, on the other hand, too much thick, starchy food, as bread and butter. Scraped raw beef is of undoubted value, but the quality of the beef should be daily carefully examined, as the risk of tape worm is considerable, and the writer has seen more than one case in which tape worm was introduced in quite young children by the use of infected raw beef. Thin sandwiches made with cooked bone marrow are very readily taken by young children.

In prescribing a diet for a severe case of rickets in a child eighteen months to two years of age, it should be borne in mind that it cannot digest milk any better than say a healthy infant of four to six months. Mixtures of milk and whey are useful, as the latter contains nearly all the lime and phosphates of the milk.

Diet for a Child of Eighteen Months. Rickets severe (no solid food, 20 oz. of whey with 10 oz. of milk)—

7.30 A.M.—8 oz. of milk and whey, with the addition of rusks, bread-crumbs, or a tablespoonful of well-boiled oatmeal porridge.

10.30 A.M.—8 oz. of whey and milk.

1.30 P.M.—Beef tea, with shredded underdone beef added, or egg with strips of toast, or finely pounded underdone beef, or mutton and fruit juice, or baked apple pulp.

4.30 P.M.—8 oz. of milk and whey, with some cereal added.

7.30 P.M.—Milk and whey or beef tea.

In milder cases, or as improvement takes place, give cream, bacon fat, light puddings, and bread and butter.

Of medicines the most important are those which assist digestion and help to secure a daily thorough evacuation of the bowels. Of the former, nitro-hydrochloric acid dil. 1 to 3 minims, liq. euonymin et pepsin 15 to 20 minims, aq. laurocerasi 5 to 10 minims, sp. chloroformi 2 minims, syrup and aq. to 2 drachms, form a useful combination. "Mist. rhei co." given in conjunction with a dose or two of hyd. c. cret. every week answers well in many cases. For regular and long-continued use as a tonic laxative the syrup cascara sagrad. is the best drug that can be used. Glycerine and oil enemata may at times be necessary, but they are not good for continual use. Cod-liver oil, especially in the form of emulsion, is of unquestioned service, but perhaps more so in the second year than earlier; and when the digestion is not greatly impaired, lipanin, *i.e.* olive oil with 6 per cent of oleic acid, is recommended by Freyberger instead of cod-liver oil, as it emulsifies better. Iron, arsenic, and iodine are usually given in the anæmic cases with enlarged spleens; or Levico water may be given (blue label) in doses of two to four tablespoonfuls daily; iron somatose, or Hommel's hæmatogen, are also useful when iron is indicated.

Phosphorus has been strongly recommended, especially by Kassowitz, Wegner, and Jacobi, in the treatment of rickets, but it is comparatively little used in this country. Wegner and Stoeltzner have shown that in animals it produces a sclerosis of bone tissue. Freyberger claims for phosphorus that it is useful in laryngismus in doses of gr. $\frac{1}{200}$ once or twice a day. The following combination may be given: Phosphor. $\frac{1}{12}$ gr., ol. limonis 2 minims, lipanini 3 oz., half a teaspoonful twice daily for a child of two years (Freyberger). The elixir phosphori (B.P.C.) may be given in 10 to 15 drop doses, two or three times daily.

Von Mettenheimer has recommended extract of thymus gland in the treatment of rickets, and used it with apparent success, but his success has not been confirmed by others.

More recently, Stoeltzner has claimed for the extract of suprarenal gland a specific action in rickets; according to this authority it exerts a marked influence in checking the sweating, influencing favourably the eruption of the teeth, as well as the calcification of bone. In some of the post-mortem examinations made by him on rickety children that had been treated by this extract and had died of some complication, he has, he believes, found evidence of its action in modifying the course of the disease as far as the bone formation was concerned. The dose he uses to commence with is half a five-grain tabloid (B. W. and Co.) daily for a child of 18 lbs. weight. Stoeltzner found the suprarenal extract was of no use in laryngismus; for the latter he uses phosphorised cod-liver oil.

During the second year of life, and sometimes later than this, much difficulty may be experienced in preventing deformities of the limbs and spine. The bones are soft in severe cases of rickets, and the ligaments readily stretch and deformities ensue in spite of much care. In children in hospital confined to their cots, the tibiæ will bend inwards in their lower thirds from the legs being flexed under them as they sit up in bed. When the child is able to crawl or stand with help, it will want a great deal of looking after and amusing if deformities are to be prevented. In the milder cases seen in private practice the deformities are not usually so severe as those of the hospital class.

While splints and cutting operations belong to the domain of the surgeon, and are often required in severe deformities, a good deal can be done in the milder and early cases, while the bones are still soft, to correct the deformities by manipulation and to strengthen the muscles and ligaments by massage and baths. Osteotomies are chiefly of value in the later stage when the bones have become hard; if performed too soon, there is danger of relapse if great care is not taken to keep the child off its feet for many months after the operation.

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Rigor Mortis. *See* Medical Jurisprudence.

Ringworm. *See* Skin, Parasitic Affections of.

Rodent Ulcer.

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Rodent ulcer is the term commonly but rather unfortunately applied to a little-malignant variety of carcinoma, which is characterised by certain peculiarities. It was first described in the early part of last century by Jacobs of Dublin, an ophthalmic surgeon, whose attention was drawn to it from the fact that it so frequently occurred in the neighbourhood of the eye. While it has been observed on almost every part of the surface, it is most common upon the upper part of the face, and indeed the great majority of cases are further limited to two situations—the angle of the nose where it rises from the face, and the outer angle of the eye. The former of these is affected probably twice as often as the latter.

It is often stated to be a disease of late life, but that statement will not stand critical examination. The statistics from which it is derived are taken from hospital reports, which give the age of the patient at the date of operation, and ignore the fact that the disease may have lasted for ten, fifteen, or more years. It has been seen in patients as young as fourteen, but its earliest signs are perhaps oftenest observed between thirty-five and forty-five. It commences as a small nodule *below* the surface of the skin, and has usually an existence of many years in this form before the ulceration, which the name leads one to expect, appears, then the centre sloughs away, and the typical rodent ulcer is developed. The surface is flat, and the ulcer terminates in the abrupt, raised, rounded, or "rolled" edge which is so characteristic of the disease. It is due to the presence beneath the skin of cancerous alveoli, which elevate and stretch the skin over them. To this stretching is due the shiny polished appearance which the rodent edge invariably has. If left alone the disease steadily progresses, attacking everything it meets, eventually eroding the bones of the skull, and thus leading to death, but in spite of its local malignancy metastasis is practically unknown. During the whole of its course, unless it should attack sensitive structures, the patient rarely complains of any pain. Itching, however, is usually a prominent and early symptom.

In its early stages if the parts are kept clean the ulcer may heal up, and then a very characteristic appearance is presented, which has been compared to a flat valley surrounded by ridges of hills. The patient often congratulates himself that the disease has disappeared, but the improvement is a misleading one, for the growth continues to extend under the surface.

The origin of the disease has been the subject of much acrimonious discussion, some maintaining that it developed from the hair follicles, and others that it arose from the sweat, or sebaceous glands. In the architecture of the growths there is often a suggestion of one or other of these origins; one form may have a tubular appearance, and thus suggest the sweat gland, another may spread in an acinous manner like the sebaceous one, while in some the close packing of the cells suggests the "whorled" appearance often seen in the hair follicles. Most of the observations have been made on cases of considerable standing If the tumours are removed in the pre-ulcerative state, or better still, if moles are removed before there is any question of their being malignant, all the various forms may be found. In a chance collection of moles all the varieties of architecture seen in rodent ulcer may be observed. One form is tubular, another acinous; in another the cells are arranged in an alveolar manner; indeed it is, without a knowledge of the history, often impossible to say whether a particular specimen is a mole or a rodent.

Moles are really collections of epithelial cells which have become detached from the surface epidermis, and in most cases maintain a purely vegetative existence. If specimens are taken from infants or young children their development from the surface epithelium may be readily studied; and it is probable that Sir Benjamin Brodie's clinical observation made long ago, that rodent ulcer developed from an irritated mole, is the correct one.

Diagnosis.—In the pre-ulcerative stage, where it resembles a mole, there are no points of distinction from that except the fact that it is increasing in size, and the removal of moles in the suspicious situations is always desirable. When ulceration has set in it may be confounded with syphilitic or tuberculous ulceration, both of which are frequently seen on the face. From the former it should be easily distinguished by its relative slowness of growth; for a syphilitic ulcer will attain in a week or two a size which it would take a rodent months to reach.

From a tuberculous ulcer the diagnosis is not so easy. While tubercle is essentially a disease of youth and rodent of middle age, exceptions occur in both cases. The tuberculous ulcer, however, lacks the characteristic edge of rodent, and the rodent ulcer the apple jelly nodules of lupus.

Prognosis.—The prognosis, unless treatment is efficacious, is extremely grave, for although the progress is slow it is steadily onwards.

Treatment.—Moles may be destroyed by electrolysis. Like all caustic methods, electrolysis has its risks, for if the destruction is not absolute the irritation may result in stimulating the disease to fresh activity. The real treatment consists in early recognition and complete removal by the knife. The majority of cases of recurrence are due to the conservatism of the surgeon, who is anxious to destroy the patient's appearance as little as possible. The incision must be quite clear of the edge laterally, and the entire thickness of the skin must be removed. Some years ago the writer received a most instructive lesson. A small rodent about the size of a silver penny was removed from the face of a lady. Next day examination of the specimen showed that the knife had divided one cancerous globule. A further portion of the skin was therefore forthwith removed, and in it was found the other half. Had the examination not been made it would have been written down as another case of recurrence, whereas the fact was that the disease had not been removed. The patient was the wife of a medical man, who reports that now, six years after the operation, there has been no recurrence. When the ulcer has reached the size of a shilling the scar left by removal is often unsightly, and in such cases the method strongly recommended by so many American dermatologists, and by Unna, and Czerny, of destroying the growth by means of arsenious acid may be adopted. It must be explained to the patient that the pain is very great, and while means may be taken to modify it, the method is inapplicable in weak, nervous patients. Equal parts of arsenious acid and acacia powder are made into a paste with a little water, and applied to the part. If the skin over the edges is thick it should be curetted, or as some recommend, be painted with liq. potassæ, which dissolves the epidermis. The duration of application depends on the extent of destruction which is necessary. Arsenic has some of the selective action which salicylic acid has on lupus; it destroys the cancerous tissue, while only inflaming what is healthy. When the destruction has been sufficient, poultices may be applied to hasten the separation of the slough and encourage the granulations to fill up the loss of tissue. This method thoroughly carried out is justifiable in certain cases, but there is no doubt that the knife, in capable hands, is a more certain method of treatment.

Perhaps one of the most wonderful of all the properties of the X-rays is their effect upon this disease. Discovered more or less accidentally by Sequeira, their use has spread, and the benefit resulting from their use is everywhere acknowledged. Exposures of ten minutes daily at a distance of four inches will often destroy a rodent the size of a shilling in six or eight weeks, with a resultant scar which leaves nothing to be desired in appearance. Even cases which have spread beyond the reach of the surgeon's knife cicatrise in a perfectly wonderful manner. The X-ray apparatus, however, is not in every one's hands, and thorough excision still remains the most dependable treatment for rodent ulcer.

Roseola. *See* Rubella.

Rubella: Roserash.

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Nomenclature.—Roseola, epidemic rossalia, epidemic roseola, roséole épidémique, roserash; rubeola, rubeola notha, rubeola sine catarrho, rubéole, rougeole, false measles; Rötheln, German measles.

Definition.—A definite and distinct zymotic disease, very infectious, and occurring usually in epidemic form in the spring of the year. It mainly affects adolescents and young adults of both sexes. It affords no protection against measles, scarlet fever, or "the Fourth disease," but protects against itself. The period of incubation is a fortnight or more. The disease is infectious even prior to the appearance of the rash, which is usually the first noticeable symptom; and its duration of infectiveness is about a fortnight. It produces no mortality or sequelæ in this country.

Geographical Range.—The disease occurs in the British Isles, on the continent of Europe, and it is known also in Egypt, India, and America.

History.—No cases in medicine are, at times, more perplexing, and involve the expenditure of greater thought and judgment than zymotic diseases. Their elucidation has bewildered and misled many of the ablest and most experienced physicians.

The disease now to be considered is perhaps the most difficult in these respects, and even now its character as a distinct disease is sometimes denied. It seems to have been known to the Arabian physicians under the name of hhamikah. Little, however, is recorded of its existence until the *early part* of the eighteenth century, when it was known by the name of Roseola; the term Epidemic Rossalia was subsequently applied. The record of the disease, however, was slight until the *middle* of the eighteenth century (1758), when the Germans described it under the name of RUBEOLA. In the middle of the nineteenth century it reappeared in German medical literature under the name of ROTHELN, which we, unfortunately, have translated by the popular name of GERMAN MEASLES.

Scarcely any term, I think, in medical language has created so much perplexity and obscurity as the word measles; for it involves inconceivable difficulty through the confusion under one name of four distinct diseases: ROSERASH, MEASLES, SCARLET FEVER, and what I have termed provisionally a FOURTH DISEASE.

This uncertainty has no doubt partially arisen from the vagaries of the disease itself; and partially also from inherent difficulties in diagnosis, by reason of its close resemblance to measles; but undoubtedly the principal cause has been an erroneous nomenclature, with the result that English measles is confounded with German measles.

It was not until the close of the seventeenth century that, mainly through the researches of Sydenham, scarlet fever was differentiated from measles; and at the end of the nineteenth century roserash is still confounded with measles, with scarlet fever, and with the fourth disease. Yet the difficulties are not greater than the differences between typhus and typhoid fevers—a problem ably solved by Jenner in the middle of last century (1849-50) with beneficial results.

These four diseases are not varieties of the same species, but are perfectly distinct and definite diseases, notwithstanding the obscuring resemblances which may sometimes appear in "certain" characteristic features.

A fundamental law in medicine—the science of our practice enforced by Cullen more than a century ago, but now too frequently ignored—is, that one attack of an eruptive fever entails immunity from a second attack in the same individual during childhood.

The "germs" of infectious diseases apparently require a virgin soil for development; a prior attack seems to exhaust the soil, or to transform it chemically by the products of their growth in such a manner as to render it incapable of furnishing a suitable nidus for the reproduction of the germs. The law is so pervading—for the insignificant exceptions may be regarded as scientific curiosities only—that for the practical guidance of our work it may be adopted as an absolute and invariable rule.

Each disease, moreover, has its characteristic seed, entirely *sui generis;* although microphytes may bear some relation to saprophytes in their origin.

But a curious fact, at present inexplicable, in the life-history of these zymotic diseases is, that the growth of some germs in the body seems to produce so essential an alteration in the soil as to facilitate the immediate fertilization and development of the germs of other diseases. For example, the concurrence, or sequence of measles and whooping-cough, of scarlet fever and diphtheria, and of measles and diphtheria, is well recognised.

ETIOLOGY.—(i.) *Predisposing Causes.*—1. Age.—Some authors assert that the disease is most prevalent in young children. In my experience, on the contrary, the sufferers are usually adolescents and adults. I have very rarely observed the disease in infants, or in children in the nursery; only occasionally in private schools, where the ages range from nine to thirteen years; and when it occurs at the public school age, thirteen to nineteen years, the elder rather than the younger boys have been attacked. After searching my record of one hundred new boys, taken consecutively, I find that twenty-eight have had, and seventy-two have not had this disease before their entrance to Rugby School at the age from thirteen to fourteen years.

2. Sex.—Each sex is equally liable.

3. Season.—The disease appertains to spring and early summer; out of 275 cases which I tabulated in 1896, all but four occurred between March and July. And it becomes epidemic every five or six years.

(ii.) *Exciting Causes.*—1. Contagion.—Rubella is one of the acute infectious diseases depending upon a specific virus arising from germs which, so far as I am aware, have not yet been isolated.

2. Mode of Communication.—The channel of extension is personal intercourse, and, when once started in a susceptible community, the disease spreads as rapidly and widely as measles—if, indeed, its speed and range be not greater. My experience is that even if isolation be adopted on mere suspicion, and without waiting for definite evidence, the disease will spread.

VARIETIES.—Until the year 1900, from want of actual proof to the contrary, I believed that there were simply two varieties of this disease: one in which the eruption resembled that of measles, the other in which it simulated scarlet fever. But I am now convinced that only one form exists, namely, that in which the eruption is of the measles type; while the scarlet fever variety is a distinct disease, which I have provisionally termed a "Fourth disease."

(i.) *Abortive* cases are frequent, and are responsible to a large extent for the spread of this disease. The difficulty is one of definite detection, as no actual illness takes place.

1. Pink Eyes.—A group of cases of roserash occurs which have no symptoms that I have yet ascertained, except *pink conjunctivæ.* And these cases, while capable of transmitting the illness to others, provide immunity against a subsequent personal attack.

2. Another group of cases of roserash may, I believe, occur (but I cannot, at present, advance beyond belief, as I have not yet satisfied myself by actual proof), without showing any symptoms beyond slight feverishness and *enlargement of the lymphatic glands*, particularly the post-cervical, the axillary, and the inguinal.

SYMPTOMATOLOGY.—(i.) *Premonitory Symptoms.*—In many instances none are discoverable—neither headache, vomiting, catarrh, nor cough, though some amount of sore throat usually exists. If the attack be severe there may be some malaise, anorexia, and drowsiness.

(ii.) *Sensations of Illness.*—Even where a very full eruption occurs, as intense as in a typical case of measles, the patient usually states that he does not feel ill, although other indications to the contrary may be visible. While in measles, I have heard the most vigorous declare that they never felt so ill in any previous illness.

(iii.) *The Temperature.*—The variation ranges from normal to 103° Fahr. or even 104° Fahr. In the latter case the temperature, in my judgment, arises from idiosyncrasy.

(iv.) *The Pulse.*—The pulse is normal, or may be increased in frequency; it always bears, however, a ratio to the temperature.

(v.) *The Tongue.*—The tongue is clean, or slightly furred. It is never coated with a thick white fur, and never peels.

(vi.) *The Throat.*—The fauces are dry in appearance, of a motley red hue, much resembling the eruption on the skin. This condition of the pharynx may occasion some amount of cough.

(vii.) *The Glands.*—The lymphatic glands throughout the body are enlarged, tender, and hard like peas—notably the posterior cervical, the axillary, and the inguinal. But they never suppurate.

(viii.) *The Eyes.*—The eyes are generally pink red and suffused.

(ix.) *The Eruption.*—The first noticeable symptom is usually the eruption.

Its appearance, *at first*, is that of minute *rosy red* dots raised somewhat from the surface of the skin, but not patches. It is first visible behind the ears, on the scalp, and on the face, especially on the oral circle. From these situations it extends to the neck and chest, and ultimately may cover diffusely, or in patches, the entire body. The minute dots become larger and gradually coalesce, forming patches of the bat's wing pattern, which so extend and alter in colour as to be indistinguishable from the rash of measles.

In other cases the spots become so diffused that the rash, in patches, resembles the rash of scarlet fever; but in this disease the diffuse scarlet fever looking rash never manifests itself from the commencement.

The eruption lasts from one to five days, according to the nature of the attack, and first fades where it first appeared. Itching of the skin occasionally occurs, as it is apt to do in all cases when hyperæmia of the skin is present.

It is evident that, in diagnosis, the eruption must not be relied on, but a consideration of the collateral symptoms is imperative.

(x.) *Desquamation.*—There may, perhaps, be a little brawny desquamation; but frequently, or rather usually, none occurs.

(xi.) *Albuminuria.*—Where albuminuria is found it is, I believe, that form only which is incidental to adolescents.

STAGES.—(i.) *The Period of Incubation.*—By this is meant the interval between exposure and the manifestation of symptoms. The first noticeable symptom in all ordinary cases of this disease is the rash, and it is from this epoch—from rash to rash—that the period of incubation can alone be calculated. It must, however, be borne in mind that the disease is undoubtedly infectious prior to the exhibition of any symptoms which the minutest scrutiny can discover.

In investigating the period of incubation of infectious diseases generally, it is essential that every case should be instantly removed on its occurrence from the house to hospital, and no communication whatever should be permitted between the sick and the healthy. Any less stringent mode of isolation is absolutely fallacious and inoperative. The period also can only be calculated from well-marked isolated cases; or from the beginning and termination of epidemics, when the cases occur slowly. An attempt to measure the incubation period during the height of an epidemic when many are succumbing daily, or to calculate it when the disease is epidemic in towns, is entirely futile. I desire to emphasise this statement, because the incubation period of this ailment is so diversely assigned. One of the leading epidemiologists, for instance, knowing my deep interest in the question of incubation, informed me some years ago that he had found an instance where the term was barely twenty-four hours, because he showed a case one afternoon to a young medical man who desired to see the eruption, and on the succeeding day the young practitioner himself was attacked with roserash. I pointed out to him, however, that the disease was exceedingly rife in London at the time; that his friend was travelling daily; and that no more infectious places existed, outside infectious hospitals, than railway carriages, trams, cabs, and churches, which are rarely ventilated during or after the services. Rubella is unquestionably one of the infectious ailments which involve a long period of incubation. And when an observer appears to find an incubation period of less than twelve days, he should, in his own mind at all events, doubt the supposed fact. The most common period is the eighteenth day; but it may range from twelve to twenty-two days; and accordingly, when a term of five days is alleged, the true period will probably be 5 + 12 days.

(ii.) *The Period of Infection.*—It is needful to repeat that, although in most cases the first detected symptom is the rash, the disease is infectious at a prior stage, for even when I have isolated on mere suspicion the disease has still spread. I am not prepared to specify definitely the length of this earlier stage; but a minimum of forty-eight hours may be fairly accepted. The extent of infectiousness after this period I am not able to assign, since all my cases being isolated in hospital, the possibility of infection has ceased. I think, however, we may reasonably assume that the disease is highly infectious until the rash attains its height, and that it gradually wanes as this fades and the brawny desquamation ceases.

My plan at Rugby is—

1. In very mild cases to isolate for ten days;
2. In the average case for 14 days;
3. And in a severe case, followed by much desquamation, to allow a few days beyond the fourteen.

In all instances disinfecting baths are given on several nights, and the clothes are disinfected as carefully as in scarlet fever.

This plan has never failed me in an experience of thirty-one years; but it may be that even these periods of isolation are longer than is absolutely necessary.

Owing to the completeness of the system of isolation and disinfection just described, which should be the plan to be aimed at in all infectious diseases, I possess no evidence relating to the retention of infection in clothes.

(iii.) *The Period of Protection.*—In my judgment there is absolute immunity from a second attack; and I believe that any contrary statement arises from confusing this disease with the "Fourth disease," or with English measles.

The disease affords no protection against English measles, scarlet fever, or the Fourth disease.

SEQUELÆ.—There are practically no sequelæ, though I have seen the submaxillary glands enlarged. Inasmuch, however, as the slightest feverish attack, for example from a cold, or even vaccination, may in the delicate or cachectic develop latent mischief, and may be answerable for a considerable deterioration of health, so this slight feverish zymotic disease may similarly act. But there are literally no sequelæ pathognomonic of it.

RELAPSE.—I have never seen a case of relapse or recrudescence, although these are stated to occur occasionally.

RELATION TO OTHER DISEASES.—The disease is of frequent occurrence in those who have had measles a short time previously, and *vice versâ*, so that these two diseases are mutually unprotective. And when the disease breaks out in a community, where some have had measles and some not, it attacks them indiscriminately, and never develops into true measles.

DIAGNOSIS.—(i.) *Measles.*—Some cases of this disease so accurately resemble measles in the eruption that, at a certain stage of the illness, it is impossible to distinguish between them. The temperature, the pulse, and the eruption are frequently almost identical—the differences varying merely in degree. The distinctions, therefore, between a severe case of roserash and a mild case of measles will puzzle the most wary. It is only by seeing the disease from the commencement, or by studying a group of cases and obtaining an accurate history, that a valid diagnosis can be effected. This difficulty mainly arises from the fact that the diagnosis is apt to be based on the appearance of the eruption alone, without the devotion of sufficient attention to the history of the attack, the incubation period, and the presence or absence of other symptoms.

Those alone who are connected with the treatment of the young when congregated in large numbers realise the difficulty and doubt produced by classing two perfectly distinct and definite diseases under the common name of MEASLES without the prefix of "English" or "German." This confusion may be largely rectified by calling "English measles" (Morbilli) MEASLES, pure and simple, and designating German measles (Rubella) ROSERASH. At present when a pupil is certified as having had "measles" it frequently means that he has had the German variety, and *vice versâ*, and thus he starts an epidemic amongst those supposed to be protected by a previous attack.

The prodromata of measles with three days' malaise, catarrh, and cough accompanied by fever are quite pathognomonic of measles. The eruption, not appearing until the fourth day of measles, instead of the first as in roserash, is, however, quite convincing. The glandular hypertrophy is absent in the early stage of measles. And the period of incubation is usually of much shorter duration in measles.

Sequelæ are frequent in measles and often formidable, while they are absent in roserash.

(ii.) *The Fourth Disease.*[1]—Until April 1900, when I was able finally to prove what I had long suspected, I had, with the profession generally, confused two diseases under the head of rubella. I concluded that there were two varieties of this disease: the one showing a rash resembling that of measles, the other almost identical in appearance with scarlet fever. It is quite clear, however, that these are not varieties of the same disease, but two distinct diseases, neither of them protecting against the other. For in a series of cases of the "Fourth disease" 42·1 per cent had already suffered from roserash (see also "SCARLET FEVER").

(iii.) *Roseola Simplex.*—This eruption also, which arises in hot weather after chill, or as the product of various indigestible articles of diet, closely resembles roserash. It is, however, distinguished by the absence of fever, as well as by the absence of enlargement of the lymphatic glands.

(iv.) *Caterpillar Rash.*—During the season when roserash is rife, as I pointed out in the *Lancet* in 1881, boys are very fond of keeping caterpillars, some species of which occasion a rash and a redness of the eyes which closely resembles the signs of roserash at its commencement, and may involve considerable difficulty in diagnosis during the middle or the beginning of a roserash epidemic. The only safe plan is isolation for twenty-four hours.

The chief creatures which occasion this rash are:—the oak-eggar or Bombyx quercus, the Liparis auriflua, the Arctia caja, and Arctia villica, and the common drinker or Odonestris potatoria. On the part of the body on which they crawl, or which is touched by the fingers that have handled them or cleaned out their cages, a measly rash appears. As a rule it commences on the fingers; these rub the eyes, and typical measly-looking eyes are presented. Then the face or neck is scratched; or, if in cricket-clothes, any part of the body, and then ensues a subcuticular or a measly-looking rash. So common is this occurrence in early summer that in making a diagnosis this possible origin is always in my mind.

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[1] "On the Confusion of two different Diseases under the Name of Rubella," Clement Dukes, *Lancet*, 14th July 1901; "Fourth Disease," J. J. Weaver, *The Journal of State Medicine*, 1901.

(v.) *Flower Rash.*—The eruption arising from handling the Primula obconica also closely resembles the rash in its early stage.

(vi.) *Drug Rash.*—Some drugs may also create a difficulty when they are administered, as they produce a very similar eruption, such as the bromide rash, or the copaiba rash.

Prognosis.—The prognosis is favourable, as the ailment is the simplest of the zymotic diseases. Under the head of "Sequelæ" I have pointed out the cases where even this mild illness may cause anxiety.

Treatment.—(i.) *Isolation.*—All cases of infectious illness should be isolated, and, where possible, in a separate house or hospital. Even this slight illness should be included in the rule, since it is not necessary that all should suffer from it, and it is exceedingly inconvenient and unpleasant when large numbers are simultaneously attacked, even although the illness may neither be severe nor fatal. Isolation should be enforced, whenever possible, before the appearance of the eruption if the epidemic is to be kept under control. The difficulty is that so many fall without any palpable previous symptom. Still, during an epidemic, when the young look heavy and are not quite themselves, the time has arrived for isolation.

(ii.) *Prophylactic.*—When the patient has been isolated the question arises as to the requisite treatment for a safe and speedy cure, and the earliest possible release.

My invariable custom in average cases is to keep the patient in bed for five days, to get him up for three days, and to send him out for six days. During these latter days he has a bath every night, and on the fifteenth day his clothes are passed through the disinfecting chamber. He is then safe, even if some desquamation continues, to mingle with his friends. In mild cases a few days less are assigned; and in more severe cases, or in the delicate, a few days more.

(iii.) *Dietetic.*—During the fever-period a milk and farinaceous diet, with plenty of water to drink, is essential. As the fever subsides soups, eggs, and fish; and after a day or two the ordinary diet may be allowed—bearing in mind, however, that in children and adolescents the appetite is enormous, and may be satisfied, since growth proceeds even during illness.

(iv.) *Curative.*—Nothing is necessary beyond the ordinary rules of treatment for slight febrile ailments, unattended by complications.

(v.) *Convalescents.*—In respect of the period of convalescence of the young I desire to add a word on their behalf. Time passes wearily with them during isolation from their friends. They cannot always be reading, nor is this beneficial; but they do need in-door games and out-door games as conducive to a happy restoration to health.

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Sacrum. *See* Fractures.

Salivary Glands, Disorders of.

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The disorders of the Parotid gland have already been considered (vol. ix. pp. 231-238). The other salivary glands are the submaxillary, the sublingual and certain additional glands, the chief of which are the glands of Nuhn or Blandin.

Anatomy

The Submaxillary glands are placed symmetrically beneath the lower jaw, one filling the space on either side which is left between the two bellies of the digastric muscle. Each gland lies in a triangular space formed on two sides by the splitting of the superficial cervical fascia, whilst the base of the triangle is the periosteum covering the inner aspect of the lower jaw. The submaxillary gland is intermediate in size between the parotid and the sublingual, and usually weighs rather more than a quarter of an ounce. It is roughly almond-shaped, but there is a deeper portion which is prolonged forwards and inwards between the mylohyoid, the hyoglossus and the genio-hyo-glossus muscles and below the lingual nerve.

The superficial portion of the gland is covered by the skin, fascia and platysma: it rests upon the styloglossus, the hyo-glossus and the mylohyoid muscles, and is grooved posteriorly and above by the facial artery. The duct of the submaxillary has long been called Wharton's duct, after its discoverer Thomas Wharton, the Yorkshireman (1610-1673). It runs upwards and inwards with the deep portion of the gland, and opens on the top of a small papilla at the side of the fraenum of the tongue. The duct is about two inches in length and has a thinner wall than the duct of Stensen. The gland receives its blood supply from the facial and lingual branches of the external carotid artery, whilst the veins empty themselves into the anterior jugular and facial veins. The nerves are branches of the mixed lingual and chorda tympani nerves either directly or by branches from the submaxillary ganglion, as well as from sympathetic branches of the plexus surrounding the facial artery. They are interesting because the termination of nerves in gland cells was first demonstrated in the submaxillary by Pflüger, and more recently by Paladino. The lymphatic glands of the submaxillary region are arranged in two groups, the more anterior lying on the mylohyoid muscle, the more posterior embedded in the submaxillary gland — one or more glands being found between the submaxillary gland and the hyoglossus muscle. These glands are of especial importance as they become enlarged in cancer of the tongue, and in performing any operation for epithelioma both aspects of the submaxillary gland must be carefully examined for enlarged lymphatic glands.

The Sublingual gland lies on the floor of the mouth so close to the mucous membrane that its outline may be seen projecting as a crest running fore and aft on either side of the fraenum linguae. It weighs about two drachms, and is thus the smallest of the three chief salivary glands. The sublingual gland lies upon the mylohyoid muscle, and has behind it and upon the inner side the genio-hyoglossus, the gustatory nerve, Wharton's duct and the deep part of the submaxillary gland. The sublingual gland consists in reality of a number of individual glands crushed together into the semblance of a single gland. It has therefore many ducts; the main one, called the duct of Rivinus or Bartholin, runs close to Wharton's duct, and either opens into it or close to it on the floor of the mouth. The smaller ducts open by eight to twenty orifices on the floor of the mouth between the fraenum and the ranine vein. The arteries are derived from the sublingual and submental branches of the facial artery, the veins empty themselves into the ranine, whilst the nerves come from the united lingual and chorda tympani and from the sympathetic.

The accessory glands are the glands of Weber situated at the back and side of the tongue just beneath the circumvallate papillæ and the glands of Nuhn, situated beneath the mucous membrane and some fibres of the genio-hyoglossus muscle at the tip of the tongue, where they open by several ducts.

INFLAMMATIONS

THE salivary glands are liable to inflammation from various causes, the chief of which are injury and infection. Foremost amongst the mechanical causes are calculi.

SALIVARY CALCULI are especially liable to be formed in the submaxillary gland and to be arrested in their passage along Wharton's duct, but they are also found in Stensen's duct of the parotid.

Pathology.—Their mode of origin is uncertain. It used to be thought that they necessarily had a foreign body as a nucleus, or that they were formed by the precipitation of the salts contained in the saliva. Advancing pathology, on the analogy of concretions in the vermiform appendix, teaches that although these causes may sometimes act, a slight but chronic microbic infection is the most potent factor. The calculi are usually single, but as many as ten have been found occasionally. The shape is moulded to their situation, usually elongated and rounded when they lie in the duct, they are often irregular in outline when they are removed from the gland. They vary greatly in colour, from white, through grey to red and black. Sometimes they are brittle and are easily reduced to a powder by gently pressing between the fingers, at others they are stonily hard. Chemically they consist chiefly of carbonate and phosphate of lime with an organic basis. The presence of a calculus may lead to acute dilatation of the gland, to an acute inflammation, which may end in resolution or suppuration, or to a series of chronic changes ending in sclerosis and atrophy.

The symptoms vary greatly. In some cases the calculus may be discharged spontaneously or a pricking sensation may lead to an examination of the floor of the mouth, when the calculus may be seen projecting from Wharton's duct, from which it is easily removed. More usually, however, the presence of a calculus impacted in the duct causes pain, which becomes worse when excitation of the gland leads to increased flow of saliva. The pain may then be very intense, and may radiate to the ear on the same side. It is sometimes accompanied by evidence of vasomotor disturbance, as is shown by an acute œdema beneath the mucous membrane of the floor of the mouth, which is sometimes called an acute ranula.

Salivary calculi have been mistaken at various times for dermoids, lipomata, ranulæ and malignant tumours, more rarely for tuberculous disease, and occasionally for periostitis of the jaw, and for ossifying tumours of the floor of the mouth. It should be borne in mind that calculi in the gland give rise to less marked symptoms than those in the duct, but that, on the other hand, they are more likely to cause an abscess.

The treatment is prophylactic and curative. The prophylaxis consists in keeping the mouth clean and sweet, by brushing the teeth and using appropriate mouth washes: whilst the curative treatment is to remove the calculus. This should always be done, if possible, by an incision inside the mouth, but in long-standing cases where there is reason to think that the submaxillary gland is destroyed as a result of the inflammation, the whole gland may be removed by an incision carried beneath the jaw.

TUBERCULOUS INFLAMMATION of the salivary glands may occur in two forms. It is usually an inflammation beginning in the lymphatic glands lying in immediate relation with the affected salivary gland: more rarely it is a true inflammation of the salivary gland itself. The lymphatic glands are in closer relation with the parotid than with the submaxillary gland, and cases of tuberculosis of the parotid are consequently more numerous than of the submaxillary gland.

SYPHILITIC INFLAMMATION.—Manifestations of tertiary syphilis have been observed in the submaxillary, the sublingual and more rarely in the parotid gland. In the sublingual the whole gland has become uniformly enlarged: in the submaxillary only portions of the gland are affected, whilst in the parotid it is doubtful whether it is not the lymphatic glands rather than the gland itself which is affected. The prognosis is good, for the swelling subsides when iodide of potassium is administered.

ACUTE SEPTIC INFLAMMATION of the loose connective tissue of the throat and neck often begins in the neighbourhood of the submaxillary gland. It is known as *Angina Ludovici*, and is of great clinical and pathological interest.

Symptoms.—The inflammation attacks previously healthy persons of both sexes and apparently of any age. The incubation period, if there be one, is not marked by any symptoms. The attack begins suddenly with a rigor which varies in intensity, and is associated with a rise of temperature which reaches its maximum at once. The pulse rarely rises to more than 110-130 beats a minute, and it is characterised by intermittence, weakness and easy compressibility.

The patient complains of pain in the throat with much difficulty in swallowing, attended by great malaise and prostration, and the dysphagia increases until swallowing is impossible. The cellular tissue of the parts involved becomes acutely inflamed. The skin is hot and tense over the whole or one side of the neck, and there is a hard brawny infiltration, the swollen parts being acutely tender to pressure. The exudation into the cellular tissue is generally serous, but there may be diffuse suppuration, and sometimes localised abscesses are formed. Secondary abscesses, too, are sometimes found in the joints and in other parts of the body. Speedy death occurs in the most acute cases; but in others the inflammation subsides within a few hours, or at most a day or two, and the patient rapidly recovers. The exact channel by which the micro-organism enters the body is unknown, though it is presumably through the mouth, for the swelling first appears in the neck and afterwards spreads in both directions. The disease need not necessarily be limited to the parts first affected, for the inflammation may spread rapidly and involve the lungs and pleura, the peritoneum, and the meninges of the brain. Indeed the nervous system sometimes appears to feel the full effect of the poison after the local inflammation has completely subsided.

Treatment.—The treatment is based upon the knowledge that the effect of the poisoning is acute but transient, and that there is especial danger from cardiac failure, from suffocation, and from the difficulty in swallowing. The local inflammation should be controlled at first by cold compresses, but if the dyspnœa is urgent tracheotomy should be done early. When suppuration occurs, numerous small incisions should be made into the œdematous tissues. Stimulants are urgently needed, with such food as the patient can swallow, given frequently and in small quantities. Quinine combined with perchloride of iron and digitalis will be of service in most cases, and the imperfect oxygenation of the blood may be improved by inhalations of oxygen.

XEROSTOMIA

The salivary glands sometimes strike work entirely and permanently without any known cause, and there results the condition known as xerostomia or dry mouth. But the loss of function is not limited to the salivary glands, for the nose and eyes are often similarly and simultaneously affected. Out of forty recorded cases thirty-two occurred in females, the mouth and tongue were alone affected in thirty-six, the nose also in ten, and the eyes also in seven. In these cases the tongue appears red, cracked, absolutely dry, and the papillæ are markedly atrophied. The inside of the cheeks and the hard and soft palate are dry, whilst the mucous membrane of the mouth is soft, smooth, shining, and pale. The teeth often crumble away or fall out. The general health of the patient remains unimpaired and the digestion does not appear to be affected, though swallowing is difficult and the speech is hampered by the dryness of the throat. All the salivary glands must be implicated, but the parotid alone shows any gross lesions. It is sometimes enlarged either permanently or intermittently, occasionally it is tender and once it ulcerated.

No treatment is curative, but some improvement is said to have taken place after the administration of pilocarpin in doses of one-twentieth to one-tenth of a grain given by the mouth.

PTYALISM

Ptyalism or salivation is an unduly abundant flow of saliva due to excessive activity of the salivary glands. It is thus the opposite condition to that producing xerostomia. It occurs physiologically in pregnancy and during dentition. Pathologically in various affections of the mouth, in hydrophobia, and in some fevers: therapeutically as a result of the administration of mercury, pilocarpin, iodine, and copper salts. The condition must be treated casually, but increased comfort will be obtained from astringent mouth-washes, and especially from a solution of potassium chlorate of the strength of twenty grains to the ounce.

TUMOURS

The tumours affecting the salivary glands may be classified as innocent and malignant. The innocent tumours being further subdivided into cystic and solid.

RANULA

Ranula is the name given generically to all cystic tumours of the floor of the mouth which are formed in connection with the salivary glands. Ranulæ are either sublingual, submental, or congenital.

THE SUBLINGUAL RANULA is the ordinary form of tumour. It is situated in the floor of the mouth, and appears at first on one side of the frænum of the tongue as a tense, shiny, and bluish swelling, which often attains so large a size as to push the tongue upwards, thus interfering with speech and mastication. The mucous membrane moves freely over the tense cyst, and incision of the swelling allows of the escape of clear fluid, which is sometimes as thin as saliva but is more often glairy. Microscopical examination of the fluid shows that it contains epithelial cells in various stages of cystic degeneration. Chemical investigation proves it to contain mucin and albumin, whilst it is free from any amylolytic ferment or sulphocyanide of potassium. It is not therefore simple or inspissated saliva.

Pathology.—It was taught for a long time that a ranula was due to blocking of Wharton's duct. But this can be disproved by the fact that in some instances a bristle can be passed along this duct when a ranula is present. Pathological opinion then shifted and said that a ranula was due to a dilatation of the glands of Nuhn or Blandin which lie near the front of the under surface of the tongue covered by some fibres of the genio-hyo-glossus. But microscopical examination of the walls of the cyst show that they contain pouches and diverticula lined by glandular epithelium in various stages of cystic degeneration, and that they are not simply derived from dilated ducts. The more likely explanation of a ranula is to be found in the fact that it is a true cystic degeneration of some of the many glandular structures in the floor of the mouth. Its origin is not always the same, as it may sometimes be formed by the cystic degeneration of the submucous follicle, sometimes of the sublingual gland, and less frequently of the glands of Nuhn.

Treatment.—Simple incision of a ranula is neither easy nor serviceable, as the mucous membrane slides over the tense cyst wall so readily that it is difficult to puncture the cyst, and if only a small opening be made the cyst rapidly refills and becomes as troublesome as ever. The cyst should therefore be dealt with methodically. The patient should be placed in a good light, and the floor of the mouth should be rendered insensitive with cocaine. The mucous membrane is then seized with a pair of nibbed forceps and incised freely over the cyst. The cyst must afterwards be opened, and as much as possible of the wall should be cut away with a pair of blunt pointed scissors. The inner wall of the cyst is then to be well rubbed with a pledget of absorbent wool wrapped round the end of a pair of pressure forceps, and soaked in a solution of zinc chloride (40 grains to the ounce). This rubbing must be done effectually, for the cyst wall may be itself honeycombed with smaller cysts. The cyst is then well washed out and is lightly stuffed with cyanide gauze. It soon heals by granulation, if the mouth be washed out two or three times a day with a solution of 1·60 carbolic acid.

SUBMENTAL RANULÆ are much less often seen than the sublingual variety, but I recently had a case in a man of thirty. The swelling appears beneath the chin as an ill-defined and fluctuating swelling, which has none of the tense elastic feeling which is so marked in the more common form of ranula. Submental ranulæ increase very slowly in size, and do not give rise to any troublesome symptoms for a long time.

Pathology.—Their origin is unknown, but it has been suggested that they may be the result of cystic degeneration of outlying parts of the submaxillary or of the sublingual gland, or that they may be sublingual ranulæ which from any cause are unable to extend into the floor of the mouth, and are thus driven to extend downwards instead of upwards. Such a cause would be the scarring of the floor of the mouth produced by the cure of a previous ranula.

Treatment.—A submental ranula which causes inconvenience should be treated through the mouth, if it is possible to make it project upwards, or if it co-exists with a sublingual ranula. More frequently, however, it has to be dissected away through a skin incision carried beneath the chin.

CONGENITAL RANULA is sometimes found on the floor of the mouth in new-born children as a result of the imperfect development of Wharton's duct, though the sublingual or the gland of Nuhn are sometimes at fault.

Treatment.—When Warton's duct is obliterated the swelling is often bilateral. The treatment consists in snipping off the imperforate papilla with a pair of scissors.

DERMOID CYSTS

Dermoid cysts occur in the middle line between the genio-hyoglossi muscles. They grow slowly, and usually do not come under observation before the patient has attained the age of fifteen to twenty. They may be distinguished from ranulæ by their central position beneath the chin, and their walls consist of skin with hair follicles, sebaceous, and sweat glands. They are filled with sebaceous matter, and are often firmly attached to the surrounding tissues. Similar cysts are sometimes seen in the submaxillary region, where they appear to be formed in connection with one of the branchial clefts. Both the lateral and the median dermoid cysts may suppurate.

The Treatment consists in dissecting them out if they are unsightly, but the operation must be carried out with due care and deliberation.

The solid innocent tumours of the submaxillary and sublingual glands are adenomata and chondromata, but they are less common than in the parotid.

THE MALIGNANT TUMOURS have the same character as those found in the parotid. They are endotheliomata, formerly called mixed celled tumours, sarcomata in their various forms, and in the case of the sublingual and submaxillary glands, epitheliomata secondary to cancer of the tongue. When the submaxillary gland is affected it should be removed as early as possible.

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Sanitation. *See* SEWAGE, DISPOSAL OF.

Sand, Intestinal. *See* STOOL.

Sarcoma. *See* TUMOURS.

Saturnism. *See* TRADES, DANGEROUS.

Scabies, or the Itch.

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SYNONYMS.—*La Gale* (*la Gratelle*), *die Krätze, la Rogna* (Ital.) Among stablemen in London the itch is spoken of as the "dukes," very probably, according to Dr. Murray, editor of *The New English Dictionary*, a local or vulgar perversion of yukes—phonetically altered to jukes and dyukes. Compare yuke—regular northern name for itch; also *jücken*, German for to itch; *jeuken*, Dutch.

DEFINITION.—The itch is a disease due to an animal parasite, the *Acarus scabiei*, and is characterised by a special lesion, *i.e.* the burrow of the female, and by multiform lesions produced by the violent scratching.

THE PARASITE.—The Acarus scabiei (ἀκαρής, indivisible) (vel Sarcoptes hominis) is not an insect, although it is so stated in some books on diseases of the skin. In the adult condition it has eight legs, whereas insects have only six. It belongs to the Arachnida (a sub-class of the Arthropoda), and is included in the order Acaridea (Cambridge (21)).

The anatomy, physiology, and life-history of the Acarus scabiei have been minutely studied by Bourguignon (1), whose monograph and beautiful plates are well worth consulting. In this place a mere outline only of this truly wonderful creature can be attempted.

The adult female acarus picked out of a burrow is just perceptible to the naked eye as a minute, white, globular speck. Magnified, the animal is seen to be somewhat tortoise-like in shape, and provided with eight legs in pairs: two pairs situated anteriorly near the head, and armed with suckers, and two pairs more posteriorly, with a long seta at the extremity of each leg. The legs are supported by chitinous frameworks ventrally situated. The forelegs are employed to afford support in starting burrowing operations. The female may contain one or more oval eggs.

The male, whilst agreeing in a general way with the female, is smaller; moreover, the most posterior leg on either side is provided with a sucker instead of a seta for purposes of copulation. Posteriorly, too, in the median line there is a horse-shoe shaped chitinous framework with the penis.

Mégnin (22) gives the following measurements: female 0·30 mm. in length by 0·26 in breadth, male 0·20 by 0·16.

The acarus is oviparous, the impregnated female constructing a burrow or cuniculus, which it leaves no more, to lay its eggs. The burrow is situated in the horny layers of the epidermis, just above the rete cells, which as a rule are not invaded, but in a bad case of itch in a leper with numberless acari, Radcliffe-Crocker noted one acarus among a score in the upper part of the rete. In her progress the female leaves behind a trail made up of ova, usually placed transversely, and fæces, perforating each day, according to Bourguignon (1), the roof of the burrow for air. The acarus has no tracheal system, but breathes by the general surface of the body (Leuckart (23)) and by swallowing air (Bourguignon (1)). The female is said to lay some fifteen to fifty eggs altogether, and once this is accomplished her mission in life is at an end, and she dies. The eggs are variously stated to hatch out in from five to fourteen days, those first laid maturing earliest. According to Dubreuilh and Beille (24) the larvæ find their way to the surface through the roof of the burrow. In the figure of a section through a burrow, magnified, the female and ova in various stages of development can be seen.

The larva has six legs only, and undergoes several moults, not true metamorphoses, before reaching the final adult male or female condition. In the first moult it acquires an extra pair of legs and becomes a nympha, that is, a non-sexually differentiated form. Later on sexual characters are acquired, the females then become impregnated, and start on a fresh cycle for the preservation of the parasite (Mégnin (22)). A moulting phase is shown by Bourguignon (1) in his plate vi. The impregnated females alone burrow; the other forms either wander freely about the body, or merely ensconce themselves in the superficial layers of the epidermis to escape detection (Dubreuilh (25)).

The animal works and feeds at night. It is not, therefore, the warmth of the bed that gives rise to the irritation. In bakers who work by night, Dubreuilh and Beille (24) have noted that the irritation came on about 4 A.M., and lasted for an hour or two. According to Bourguignon (1), patients told him the irritation was greatest between 10 and 12 P.M.

As to the cause of the irritation, the mere movements of the parasite are not sufficient to account for the violent itching. This arises from a venomous fluid (Moquin-Tandon (26)) or irritant saliva (Mégnin (22)) secreted by the acarus and introduced into the skin. Hardy pounded up eight acari in a drop of water and inoculated the back of his hand with the material thus obtained. It gave rise to marked pruritis (Dubreuilh and Beille (24)).

The anatomy of the parasite's head and mouth is extremely complicated. It has been unravelled by Bourguignon (1), who gives drawings of the magnified component parts. According to him, the acarus punctures its victim's tissues with the sharp ends of its mandibles, and then by a process of squeezing presses out the fluids and blood corpuscles on which it feeds.

GEOGRAPHICAL DISTRIBUTION AND INCIDENCE.—The itch is widely distributed all over the globe. As far as England is concerned, it is very common among the poor and not rare in the better classes. Radcliffe-Crocker's figures are 8 per cent for hospital and 3 per cent in private practice (27). In Scotland it is more prevalent than in England. In M'Call Anderson's practice it occurred in about 16 per cent of his hospital patients, and about 3½ per cent of his private cases (28). On the continent of Europe it is very common: Brittany, Norway, Italy, Greece, Corsica, and so forth. In the United States it was at one time very uncommon, but of late years it has become more prevalent, White of Boston noting an increase from 9 cases in 1880 to 165 in 1888 (29). There is no doubt the increased immigration of Jews from Poland, Russia, Galicia, etc., has influenced American figures, for in London it is comparatively common among the Yiddish who apply for relief.

I am informed that among the Tamils of Ceylon scabies is almost universal.

The fact is the disease is world-wide, the parasite being everywhere the faithful attendant of man.

Itch is more prevalent in winter than in summer, for reasons not far to seek.

SYMPTOMS.—The features of the disease are the characteristic burrows and multiform lesions, either due directly to the Acarus scabiei, or arising secondarily as a result of the scratching induced by the irritation.

The burrows or cuniculi appear as more or less sinuous, irregular lines, varying in length. They are usually short, from an eighth to half an inch in length, but much longer ones have been observed. In cleanly people these lines may be white, but in the great majority of cases they are more or less black from dirt.

The lesions directly caused by the acarus may be papules, vesicles, and pustules, but these are not present in connection with all burrows.

Scratching gives rise indirectly to excoriations, secondary pus inoculation lesions of varying degrees of severity, scabbed papules, wheals, and eczematous complications.

The distribution of the eruption, besides being present about the hands and wrists, is found in men to extend from the level of the nipples to the knees in front, the genitalia being very frequently involved, and occupies the buttocks only posteriorly, especially in tailors, carmen, and cobblers. In women the lower part of the back, being within reach of the hands, is also involved. In them, too, the breasts are often affected. In infants the feet are commonly the seat of pustular lesions. The head and face, except in infants, are free.

The above description applies to an ordinary case, but the eruption is at times so much modified by the individual habits and occupation as to be misleading. In the first place, no burrows may be found, as in bricklayers, washerwomen, and so forth. With very cleanly people, who use plenty of soap and water, and nail brushes, the hands may show very little, and the lesions about the body be slight and indefinite. In such cases the diagnosis may be extremely difficult.

On the other hand, in the so-called Norwegian itch the whole of the body, including the face, may be involved. These extreme conditions have been observed chiefly in lepers, in whom, owing perhaps to apathy and insensibility, the disease goes on for years uncontrolled. In a young tuberculated leper, who was under the care of Radcliffe-Crocker (30), the limbs were thickly encrusted with an epithelial mortar-like deposit. Scabies was not suspected during life, as the itching was never very great. A portion of skin removed at the necropsy showed the epidermis to be riddled with acari in all stages.

Animal Scabies.—An extreme case of itch contracted from a horse has been recorded by Besnier and Mégnin (31), in which the latter found the Sarcoptes scabiei, var. equi. The man's eyebrows, beard, and hair were thickly crusted, and his body was covered with closely aggregated papules, giving the skin the appearance of shagreen leather.

Willan and Bateman (32) figure a bad case of itch contracted from a pig.

An ill-defined, slight papular eruption has also been observed in the human subject, contracted from dogs and cats, but the acari of these animals do not thrive on man.

Ætiology.—Scabies is a contagious disorder due to a parasite, and from what has already been said, for the disease to arise it is necessary that an impregnated female should find her way to a new host, upon whom she may start her burrowing proclivities. For this to take place, prolonged contact with itchy persons or things, such as occurs in sharing the same bed, and so forth, must take place. Popularly it is thought that shaking hands is sufficient, but this, to say the least of it, must be a most unusual mode of infection. Wearing infected gloves leads to recurrences in patients who have been cured, and Radcliffe-Crocker has pointed out that the trousers' pockets may be a source of reinfection. In connection with the latter observation, it is possible that the well-to-do may contract the disease from their clothes, for male wearing apparel is made up by tailors in their own homes. Of late years much of this kind of work has fallen into the hands of Jews from Poland and Russia, who are steadily populating Soho and other parts of the West End of London, and, as I have said, scabies is not uncommon amongst them.

The Acarus scabiei is no respecter of persons, the young and old, rich and poor, are all one to him in his determination to perpetuate his species. But where the victim is dirty and careless the parasite stands a better chance in the struggle for survival. Burrowing operations are best carried out undisturbed.

Diagnosis.—In well-marked cases the diagnosis is easy, although from want of attention to *all* the facts the disease is not infrequently overlooked.

To avoid errors the patient should be thoroughly examined. This can be done even in the case of private female patients with a little tact.

The distribution as a whole is of primary importance. The lesions about the hands and wrists, scattered about these parts *without order or regularity*, is a striking feature. Burrows should be sought for, with a watchmaker's lens, between the fingers and about the bends of the wrists. With a little care the recent end of a burrow can be made out—indeed, the female acarus can sometimes be discerned as a minute rounded elevation, and by inserting a pin or a finely-pointed needle on a holder at this spot the parasite can be picked out. An important point to bear in mind is that the acarus is not to be found in vesicles or pustules. To convince the unbelieving the parasite should be shown under the microscope.

On the other hand, ill-developed cases may present great difficulties in arriving at a correct conclusion. It is here that the social position must not be allowed to influence the judgment and outweigh all the positive factors taken together. These are—itching at night, especially between the fingers, the distribution of the scratch-marks, the presence of a burrow. As far as the last-named is concerned such may not be found, for the reasons given, even after careful search with a lens. The probabilities of the case being scabies must be carefully weighed, and the diagnosis arrived at even without the assistance of a burrow. A careful examination, however, may be rewarded by finding a burrow, when an attempt to secure the acarus should be made in the manner aforesaid, and its capture would, of course, clinch the matter.

Sometimes the fact that more than one member of a family is affected will be of diagnostic assistance.

In babies an *irregularly scattered* pustular eruption about the hands and feet, especially between the fingers and toes, is practically bound to be scabies, and a little care will usually confirm the impression. The mother in such cases will often be found to be a sufferer herself.

Animal Scabies.—In ill-defined pruritic eruptions contracted from animals the lesions are usually slight. No burrows or acari would be found. The diagnosis would be helped by the knowledge that several children, for instance, were affected, and a pet dog suffering from some skin disease (mange) kept in the house.

Differential Diagnosis.—The chief difficulty presenting itself is the exclusion of eczema of the hands. If it be borne in mind that in eczema the vesicles are minute and grouped, whereas in scabies the vesicles and pustules are discretely scattered about without order, matters will be much simplified. Another point to remember is that an eczema or dermatitis may mask and complicate the scabies as a result of treatment (strong sulphur ointment applied indiscriminately and for a long period). If the eczema be acute and extensive, it would perhaps have to be dealt with first before a definite conclusion could be arrived at. Yet the history of the development and the body-distribution of the general eruption, apart from the eczema, would make the diagnosis certain.

In some rare instances the patient may be suffering from other conditions simultaneously with the itch. For instance, I have seen a bad generalized secondary syphilide complicated with a marked pustular eruption arising from scabies. Its occurrence in leprosy has already been referred to. Again, there may be both pediculosis corporis and scabies, and even in addition pediculi capitis et pubis. I saw a man at the Saint Louis Hospital suffering from severe scabies with no less than twelve indurated chancres about the penis. The virus had found twelve open doors, the result of itch.

Urticaria may be a prominent feature, and quite put one off the track, unless care be taken. This emphasises the importance of careful examination with a lens, which will often be rewarded by the capture of the acarus. The fact that other members of the family itch would be a finger-post in the right direction.

The differential diagnosis from pediculosis vestimentorum rests on the quite different distribution of the complaint, viz. the upper part of the back and about the shoulders, usually in elderly broken-down individuals (see "Pediculosis").

Urticaria papulosa (see "Lichen Urticatus"), which occurs chiefly in children, has more than once been taken for scabies. In the former condition the wheals leave behind them pale red papules with scabbed tops as a result of the marked pruritus. The absence of burrows and of lesions between the fingers would be against itch.

In infants, again, scabies should not be taken for congenital syphilis. Besides the positive signs of the former, the absence of corroborative luetic symptoms would point to the true diagnosis.

Another disease, uncommon in this country, viz. prurigo (Pruritus mitis of Willan and P. ferox of Hebra), would be chiefly excluded by the duration, which would, unless seen very early, extend over years, as it usually begins in the first year of life. In it, as in scabies, the lesions are multiform. They vary from pale, small pin-head papules to pustules. The eruption affects the limbs, which may be covered with red and scab-topped papules and crusted pustular lesions. The skin is rough and thickened as a result of the chronic nature of the disease. No burrows would be found, and the disease is not contagious, though more than one child of the same family may be affected (*vide* "Prurigo").

Barber's itch, barmaid's itch, bricklayer's itch, are not itch at all, but come under Tinea sycosis (barber's itch) or trade and occupation eczemas.

Prognosis.—This is favourable.

Treatment and Prophylaxis.—the first thing to aim at in the treatment of scabies is to open up the burrows that the remedy may reach the acarus. This object is attained by the use of soap and water, and a brush in good condition. A second point of importance is to disinfect the clothes and the bed linen, either by baking or boiling. Old gloves must be destroyed, and Radcliffe-Crocker insists that the trousers' pockets should be hot-ironed thoroughly to prevent re-infection.

From the prophylactic point of view it is very necessary, where several members of the same family are affected, to treat them all simultaneously, otherwise the disease will be perpetuated and become hydra-headed.

A common and effectual method is to rub in ung. sulphuris after opening up the burrows. This is a little severe in some cases, as it may lead to a dermatitis on its own account.

Where baths can be obtained the disease can be cured in three sittings (three to make sure) in the following way:—The patient soaks in a sulphide of potassium bath at 100° (℥ij.-iv. to 30 gallons) for a quarter of an hour. He is then scrubbed with a hard and sound flesh-brush, and remains in the bath for another quarter of an hour. *The bath must not be* a metal one, as it would be spoilt by the sulphide formed.

In children, and for private cases, the following ointment is sufficient: Naphthol β ʒss., cretæ prep. ʒss., adip. ad ℥j. It should be rubbed well in between the fingers and parts affected after soap tubbing and scrubbing with a brush, and left on all night. In the morning a plain warm-water bath should be given. This repeated three nights running, if properly done, will effect a cure. In young children a tooth-brush can be used to open up the burrows.

In poor-law infirmaries the following is used: Quicklime ℥j., sulphur ℥v., water to Oj., stirred up and thoroughly filtered, made up to twenty ounces again, and then with a stiff brush well rubbed into the parts after a soap and water bath.

Many other remedies have been recommended, such as ung. sulph. ʒj., bals. Peruan. ʒj., adipis ℥j.; Styracis liq. ℥j. adipis ℥ij. (M'Call Anderson)—and so forth. The sulphur compounds are liable to set up a dermatitis.

Wearing sulphur bags and sprinkling sulphur in the bed have also been recommended.

Should the patient become re-infected, a little parasiticide ointment (such as naphthol ointment, *vide supra*) should be rubbed into the fresh papules.

In many cases, because the cured patient continues to itch, the parasiticide remedies are continued. This must be avoided. When the treatment has been properly carried out as above the disease is cured, but the skin may require soothing by means of lotio calaminæ for instance. In scabies it is as great a mistake to over- as to under-treat.

In connection with treatment, a few words must be devoted to those cases in which, as a consequence of the disease, the patient gets itch on the brain—a SCABIES CEREBRI. Here one has to deal with a stereotyped delusion, and it is impossible to convince such patients that they are freed from their parasites. Others, again, have never had itch at all, but labour under the idea they are loathsome and full of the vermin. Needless to say, that way madness lies. Where argument is fruitless, restraint becomes necessary, and to this end the relatives or friends should be informed of the true state of affairs. Dubreuilh and Maillard have observed scabies cerebri in several members of one family in which a case of suspected itch had occurred. (See "PEDICULOSIS.")

THE OTHER ACARI WHICH ATTACK MAN ARE THE FOLLOWING:—

I. THE HARVEST BUG (so-called *Leptus autumnalis; rouget, vendangeur, aoutat; die Ernte*—or *Grasmilbe*).—Mégnin has shown it to be the six-legged larval form of *Trombidium holosericum.* In the adult condition this tracheal breathing acarus is a vegetarian, but in its larval state it is carnivorous, not only attacking man, but also various animals (dogs, rabbits, etc.).

Geographically it is widely distributed. In Britain it flourishes during July and August (but in dry summers it may be found later) in gardens, on legumens, raspberry and currant bushes, etc., etc., and is especially prevalent apparently near the sea and on chalk. Maude has observed it to be absolutely limited to the chalky slopes near Westerham in Kent, but the parasite also occurs on other geological formations (for instance Jurassic or Oolite). It is just visible to the naked eye as a small speck, some shade of red; its colour has been variously described as brick red, bright scarlet, *rouge orangé*, like Cayenne pepper, dull red, etc. Its movements are extremely active and rapid. Women and children are specially liable to its attacks, the ankles and legs being the parts most usually affected. Men wearing knickerbockers are more liable than individuals in trousers. The parasites fix themselves to the skin, according to some at the base of the hair, but in a case recently (Sept. 1901) under my observation I could not confirm this with a lens. The fact is, the animal drops off its victim once it has gorged itself with blood, and as my patient came up to town from the south coast, my unsuccessful search may be thus accounted for. The time to look for the parasite would be when it is feeding.

Trouessart has shown that the harvest bug's rostrum or haustellum is filiform. On removing the parasite from the skin, this appendage may be surrounded by a tubular-shaped dermal eschar, which Gudden had mistaken for a part of the feeding apparatus. The larva does not burrow under the skin after the manner of the female acarus scabies. At the seat of its operations it gives rise to a small vesicle, which rapidly breaks down and itches most intolerably, leading to violent scratching. Hence wheals and scabbed superficial ulcerations, to which may be added the results of pus inoculation, and sometimes eczematous complications. Other parts of the body besides the legs below the knees may be affected. I have seen scratch lesions, few in number, about the pubes, thighs, and forearms. In another case—a young girl—the scratching had been so violent, the patient remaining without treatment and subjected to repeated invasions of the parasites, that the crusted ecthymatous ulcerations about her legs gave rise to a suspicion of syphilis, which was at once dispelled by the distribution, mode of onset, and other facts. The scalp is also said to have been affected. In a dying, comatose, phthisical patient, Gudden observed larvæ in enormous numbers, forming red areas on the skin. They had apparently been brought to the patient's bedside in bunches of flowers. Mégnin has pointed out that harvest bugs may be carried in wheat-sheaves and affect the men handling them at a distance from infected localities. In sensitive patients there may be some febrile disturbance.

Diagnosis.—The distribution, itching, and the character of the lesions, together with the time of year, and the fact that the patient lived in the country, would point to the probability of a harvest-bug origin. The sex, too, would help. A search for the parasite, with a lens and a needle on holder, might be rewarded, but the diagnosis must be made apart from the clinching capture of the acarus. The possibility of the conveyance of the parasite to towns in sheaves, perhaps in trusses of hay, etc., must be borne in mind. Scabies can be excluded by attention to the points alluded to above (*vide* p. 480).

In dogs the harvest bug is found chiefly about the orbits and nose. Animals may be carriers of the parasite to man.

Treatment and Prevention.—A number of remedies have been recommended: benzine, essential oils, paraffin, kerosene, phenate of soda, balsam of Peru, etc. No doubt all of them are effectual, but if a patient must continue to reside in an infected locality prevention must be aimed at. Women and children should wear thick stockings, the open-work kind being strictly discarded. Maude has found keeping the legs below the knees dressed with the following useful: Ol. eucalypti, ol. amygdal, āā ʒj., ol. menth. pip. ♏x. As the parasite appears to be active only in the late afternoon and evening, sitting out of doors should be avoided; and lawns near the house should be kept watered and well mown. The following will also be found useful: Naphthol, cret. præp. āā ʒss., adipis ʒj., ft. ung., or ung. hydrarg. ammon. dil. (gr. x. ad ʒj.).

II. DEMODEX FOLLICULORUM (also *Acarus, steatozoon, entozoon, Simonea folliculorum; die Haarsack*—or *Haarbalgmilbe*).—Like the Acarus scabiei, this parasite is a non-tracheate acarus. It is a minute, worm-like, degenerate arachnidan, with an elongated abdomen distinctly marked off from the cephalo-thorax, which bears four pairs of stumpy legs. It was first described by Henle (1841) and more fully by G. Simon (1842).

In length it varies from one-tenth to two-fifths of a millimetre, the abdominal portion measuring about two-thirds of the entire length. The rostrum is spade-like, and is supported by palpi made up of four joints, the terminal one being supplied with a hook, curved downwards, for locomotion and penetration. It infests the sebaceous glands and comedones, and usually several parasites are found together, but fifty, or even as many as two hundred, may be found in one follicle. They are of common occurrence, being found in about one person in five readily, but not in the new-born. The skin about the nose is a favourite situation, but Mibelli and Majocchi have found them in the Meibomian, and Henle originally in the ceruminous glands. In man they rarely give rise to any inconvenience or symptoms, but de Amicis and Majocchi have described pigmentation of the face as a complication. Dubreuilh has recently recorded a marked case of the kind in a lady of forty, in whom scrapings from the face revealed the parasite in all stages of development in enormous numbers ; but there was no sign of *Microsporon furfur*, showing it was not Tinea versicolor, for which disease, though rare on the face, it might have been taken. Domestic animals (pigs, cats, sheep, etc.), also suffer from various kinds of demodex. Follicular mange in dogs caused by a demodex may prove fatal, but Mégnin, in opposition to Delafond, Bourguignon, and Gruby, considers Demodex caninus is a different species, and not communicable to man. Demodex folliculorum can usually be readily found in individuals with a greasy skin, by expressing the sebaceous glands or comedones with the back of a knife and examining the teased debris in glycerine. Where there is pigmentation antiseptic applications should be tried, but Dubreuilh in his case found that a chrysarobin and salicylic acid ointment and ung. hydrarg. ammon. led to no change after three months. (Chrysarobin, be it said in passing, should not be applied to face.)

III. Dermanyssus avium (*Die Vogelmilbe*).—This tracheate acarus belongs to the family *Gamasidæ*. It infests poultry, and may attack man. The parasite is nocturnal in its feeding habits, lying low during the day in the cracks and crevices of hen-houses and hen-coops. Persons tending fowls are liable to their attentions. The parasite is only a temporary guest, but may repeatedly visit its host, giving rise to recurrent pruritus. The proper treatment is therefore preventive, and to this end hen-houses, etc., should be thoroughly disinfected with lime and hot water. The itching itself may be allayed by a lotion composed of liq. carbonis deterg. ʒj.-ʒij., aq. ad ℥viij.

IV. Ixodes (*Wood-ticks, Poux de bois, der Holzbock*).—This is a tracheal-breathing acarus, and, as its name indicates, it inhabits woods, etc. There are several species which temporarily fasten on man and various animals. They are not fastidious as to the host as long as they can get their meal. Wood-ticks are distinguished by the great extensibility of their integuments, swelling up to a large size (a pea or so) after a meal.

The species most common with us is Ixodes reduvius or ricinus. The female alone is parasitic, the larvæ, nymphs, and males only fixing themselves on man and animals for purposes of transport. The acarus is armed with a rostrum, which it bores into the skin, and as it is provided with minute barbs directed backward (after the manner of arrow-heads and fish-hooks), it becomes very firmly anchored in the integument. The parasite should therefore never be forcibly removed, as in that case the rostrum would break off in the puncture and give rise to pain and inflammatory swelling. The animal should be either allowed to finish its meal, or a drop of some essential oil, or turpentine, or benzine placed upon it, when it will withdraw its proboscis and die. Soldiers in the United States use tobacco juice. Blanchard has recorded the curious case of a man who complained of a small growth about the size of a hazel nut on the abdomen. It was removed, and on cutting into it, a fecundated female Ixodes ricinus (or reduvius according to Mégnin) was discovered. The creature was 8 millimetres long and of a yellowish white. Similar cases have been observed by others. Although harmless as a rule to man, ticks are responsible for Texas cattle fever, probably by inoculating a hæmatozoon, *Piroplasma bigeminum*.

Argas.—This genus is closely allied to ixodes and belongs to the same family (*Ixodidæ*). The Argas acari differ in their not being provided with a cephalo-dorsal plate. A European species, Argas reflexus, is parasitic on pigeons, and infests pigeon-lofts. In old disused lofts it may survive for long periods without food. Argas reflexus sometimes attacks man. It is nocturnal in habits, and in its mode of feeding resembles ixodes. It may produce various lesions, such as a crown-sized œdematous patch, extremely itchy, which usually subsides in the course of a few hours, but instead, it may increase in size and spread up the limb, giving rise to burning sensations, accompanied by a vesicular eruption. Giant urticaria may also occur, and affect many parts of the body, including the tongue, etc., with diarrhœa and vomiting. At the seat of the puncture a small hard papule may persist for months and even years. As in the case of ixodes, if the parasite is removed before it has finished its meal, the rostrum is left behind in the small wound The treatment is the same as for ixodes.

In the north of Persia (Meana), Argas persicus is said to give rise to severe constitutional symptoms in Europeans, the natives being immune. It goes there by the names of *Gueríb-guez*, *Malleh*, and *Keuchbhed-guez*. On the other hand, Laboulbène and Mégnin throw some doubt on the accounts of travellers as to the serious results. These two observers experimented on themselves with two Persian species, Argas persicus and A. Tholozan, which had been sent to them and kept without food for four years. They only experienced marked pruritus, with the production of a small violaceous ecchymosis at the seat of puncture, but no other untoward symptoms. Tholozan, who practised for years in Persia, has confirmed the evil reputation of Argas persicus. It infests old houses, lying perdu during the day in the cracks of the walls and floors, and issuing forth at night to feed on man and beast.

In Portuguese South Africa, Argas moubata, first described by Livingstone (Ambaca and Tete on the Zambesi. In the latter place it is called *Kufu* and *Bu*), (*Garrapata* and *Tampan* by the Portuguese). In addition to local irritation, vomiting and purging may occur. Daniels has also found it in British Central Africa. It is very necessary to search mosquito nets for the ticks before retiring for the night.

Mégnin also mentions Argas Americanus (called *Chinche* and *Nigua* in South American Columbia), which is perhaps the same acarus as Argas Talafe, which worries travellers at night in Guatemala. In South America both ixodes and argas are popularly styled garapatas.

ADDENDUM.—(*a*) ACARUS HORDEI (*Kritoptes monunguiculosus*).—Geber has given this name to a larval form found in barley, and which affects the harvesters, giving rise to great itching, eczema, or a marked urticarial eruption. Koller has also seen many cases.

(*b*) TYDEUS MOLESTRES, according to Blanchard, is common in Belgium, the acarus having been imported with guano from Peru. It attacks man and animals, giving rise to smart itching.

Scapula. *See* FRACTURES.

Scalds. *See* BURNS.

Scalp.—Among the important anatomical and physiological points to be borne in mind in connection with the scalp are—(i.) the great vascularity of the tissue, in virtue of which the healing power of wounds is promoted; (ii.) the richness in vessels and lymphatics is a source of danger in the absorption of toxines generated locally—this holds true very especially of such conditions as erysipelas; (iii.) the relationship of the scalp to the hair and hair bulbs—of special importance in relation to conditions of seborrhœa and allied disorders.

The injuries of the scalp do not call for special notice. They are to be treated on general surgical principles, *i.e.* asepsis. The rare form of injury to the scalp associated with child-birth (Cephalhæmatoma neonatorum) is described in vol. viii. p. 359. The scalp is liable to injury in cases of severe head injuries, but in these instances the lesion of the scalp is of little moment in comparison with the more severe injury to the intracranial contents (see "Brain, Surgery of," vol. ii.).

The only disease of the scalp calling for special notice is erysipelas. Erysipelas of the scalp is an important disease from two points of view. In the first place, the disease is, even in apparently slight cases, always one of considerable gravity, as a very acute general systemic infection may develop and terminate fatally. And secondly, the sequelæ of the disease are of great importance, and merit more attention than they generally receive. The writer lately saw a patient, a young woman æt. 26, whose history was as follows: Erysipelas of the scalp (severe) in October 1901, acute mania at end of November, followed by recovery and two relapses, gradually developing asthenia and emaciation, death occurring in February 1902. At the post-mortem examination there were found gross intestinal changes, evidently of a few months' duration, which were probably the focus of absorption of toxines inducing the severe mental changes. The original attack of erysipelas had apparently so lowered the general immunity as to allow acute bacterial infection of the alimentary canal, with all its attendant results, in this particular case. Such a record emphasises the importance of due consideration being paid to erysipelas of the scalp, from the point of view of its remote effects in diminishing the general and local powers of resistance in the individual.

Scarlet Fever.

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I. Nomenclature.—Scarlet fever; scarlatina; febris rubra; scarlatine; Scharlachfieber.

II. Definition.—A zymotic disease characterised by a hyperæmic exanthem of a punctiform character, diffused more or less over the entire surface of the body, which appears on the second day. It is preceded by an inflammation of the fauces, and followed by general desquamation. It is attended by fever and nervous symptoms; and the joints, serous membranes, glands, kidneys, and the subcutaneous areolar tissue are frequently involved. The entire disease is the exhibition of an infection of the organism by a specific bacillus, termed the streptococcus conglomeratus.

III. History.—Hirsch furnishes the first account of the disease as emanating from Sicily in 1543; while Ingrassias of Palermo described it in 1556. In the beginning of the seventeenth century Sennert refers to scarlet fever as another form of measles. But it was not until the sixth decade of the seventeenth century that Sydenham definitely established the distinction between scarlet fever and measles. He was followed by Morton, who, at the close of the same century, again maintained the identity of the two diseases, with a differentiation only in respect of the character of the exanthem. Since that date scarlet fever has been regarded as a distinct disease. From Western Europe, where it apparently originated, it has been constantly existent in sporadic cases, becoming epidemic from time to time, but without any regular periodicity. By means of the personal intercourse which commerce involves the disease has been conveyed to other countries, mainly those of cool or cold climates; just as in countries of variable climate, like Great Britain, the cooling autumn favours its development.

IV. Geographical Range.—The origin and native habitat of scarlet fever are unknown; nor do we possess any knowledge of the period when it first became prevalent on the continent of Europe, so intimately was it confused with measles. From Europe it has extended over most parts of the world, and more freely, in later times, on account of the extension of commerce. It appeared in Iceland in 1827, but not until 1847 in Greenland. Its presence in Africa, and especially Egypt, has been insignificant; and it is rarely found in Asia, except on the coast of Asia Minor. In India and China occasional sporadic cases only occur, and in Japan the disease is unknown. It reached North America in 1735, but was absent from South America until 1829. Its final appearance in Austria and Polynesia occurred in 1848; in New Zealand in 1854.

V. Etiology.—(i.) *Predisposing Causes.*—1. Age.—The greatest number of those affected, and those who are attacked the most severely, are children. During the first year of life, however, the liability to attack is a minimum; during the fifth and sixth years it reaches a maximum; and the susceptibility then decreases annually throughout life.

2. Sex.—The female sex throughout life is the more liable to scarlet fever in the proportion of about eleven to ten; but a fatal termination is more probable in males.

3. Season.—In this country scarlet fever is undoubtedly a seasonal disease; its minimum of cases occurs in March and April; the maximum in September and October, while its limit is attained in the last week of the latter month—in other words, its frequency begins to increase in the first cool days following the summer. It should thus be borne in mind that scarlet fever is mainly an autumn, and not a spring disease. Moreover, the mortality, as well as the prevalence, is greatest in the autumn, and least in spring. On the other hand, Dr. Ballard found that the fatality, or case-mortality, was diminished during the third, or summer quarter; increased during the first, or winter quarter; while in the spring and summer quarters the rates of mortality were equal.

4. Locality exercises some influence, as evidenced by the manner in which the disease frequently spreads in certain places, while practically absent in others.

5. Idiosyncrasy.—Few diseases exhibit so extensive a diversity in character. Sometimes the ailment is so slight that the patient experiences no sensation of illness, and during the entire period continues his ordinary mode of life; at other times its virulence is sufficient to cause a fatal termination within a few hours. Uncertainty also attends its power of infection, for even in an epidemic (and this feature is still more manifest in families) some will fail to be affected, however closely exposed; in others the attack will be so slight as to be scarcely recognisable; while the remainder may suffer so severely that, even when a fatal result does not rapidly ensue, few of the internal organs will escape its ravages, although the source of infection may have been of the mildest character. That is to say, the most virulent poison may occasion the mildest infection to another patient, and *vice versâ.* Some families, too, are so susceptible to the poison that every member of the younger branch dies when attacked. And occasionally

individuals are found who are apparently so influenced by the poison that they contract the disease in some form whenever exposed to the disease, manifesting headache, sickness, malaise, and sore throat, though usually without a rash; and persons so affected are able to give true scarlet fever to others in contact with them.

6. Station in Life.—There can be no question that poverty, implying, as it does, deficient nutrition, inefficient nursing, and overcrowding in badly ventilated rooms, tends not merely to produce an increased frequency of the disease, in consequence of the impossibility of isolation, but also to augment its mortality and its fatality.

(ii.) *Exciting Causes.*—1. Contagion.—The essential cause of scarlet fever has long been suspected to be a micro-organism, which extends from case to case by direct infection; and indirectly through the medium of the attendants, or visitors, on the sick; or by means of the fomites contained in the room, furniture, clothes and laundry, books, toys, letters, and photographs. The bacillus is not only present in the skin, but is probably contained in all the secretions. It is undoubtedly emitted in expired air, in the nasal and pharyngeal secretions; and the probability of its presence, as in typhoid fever, in the urine and the alvine evacuations almost amounts to a certainty.

2. Distance of Transmission of Poison.—The distance of conveyance by aerial convection is not great. This is manifest from the fact that residents in the immediate vicinity of a fever hospital do not suffer in consequence as those do who live in the neighbourhood of a small-pox hospital. The disease, however, will spread in a ward or in a family residence; though, on the other hand, personal contact may be the producing cause in such instances.

3. Mode of Communication.—In addition to personal contact, dispersion can also be effected through the medium of pet animals, and insects such as flies. The disease is not, however, water-borne; but it can be contracted by visiting the dead. It might be conjectured, *à priori*, that fresh milk would form an excellent channel for the propagation of the germs, and in 1870 Dr. M. W. Taylor showed that the disease could be disseminated through milk which had become contaminated by those who were either infected with scarlet fever or were in attendance on scarlet-fever patients. Since that date many epidemics have been traced to this source. In 1882 Mr. W. H. Power and Dr. Klein proceeded a step farther, and clearly proved that human scarlet fever may be caused by milk which owed its infective property to a similar ailment in the cow itself. Thomas records cases, too, of persons who were inoculated successfully with the germs of scarlet fever, and were thus protected. We shall now discuss the nature of these germs.

4. Bacteriology.—The recent researches of Dr. Mervyn Gordon have confirmed the views of Hallier and Reiss in 1869, and those of Jamieson and Edington in 1887, that the blood of scarlet-fever patients contains micrococci in abundance. These investigations also support Dr. Klein's contention, based upon analyses made during the Hendon epidemic in 1885, that streptococcus scarlatinæ, though closely resembling streptococcus pyogenes, is a distinct organism, and is causally related to scarlet fever. As a result of his most recent investigations into the bacteriology of scarlet fever, Dr. Gordon summarises the evidence as follows:—

(1) The streptococcus scarlatinæ, or conglomeratus, is a special pathogenic micro-organism distinct from streptococcus pyogenes on the one hand, and from bacillus diphtheriæ on the other.

(2) It occurs constantly in the mucous secretion on the surface of the tonsil or fauces in scarlatina, and may persist there, in some instances, for a period considerably remote from the origin of the attack.

(3) It was not discovered on inflamed, but non-scarlatinal throats, though other virulent streptococci were found.

(4) It may be present in the nasal discharges of scarlatina; but it has not yet been detected in the aural discharge.

(5) It can penetrate the system, and be obtained in pure culture from a serous effusion occurring as a complication in the course of scarlet fever.

(6) It may be present in the blood and tissues of the fatal cases of scarlet fever, and may not infrequently be obtained thence in pure culture.

(7) The characters of streptococcus scarlatinæ, as isolated from the tonsil of a mild but typical case of scarlet fever, are apt to undergo modification, when, for example, a mouse dies from infection with it; and a similar modification is found in the case of streptococcus obtained when a patient succumbs to scarlatinal infection. In each instance the modification generally comprises increase of virulence accompanied by diminution of those morphological and cultural characteristics that distinguish streptococcus scarlatinæ from the streptococcus pyogenes, though close examination shows that sufficient differences still survive to permit the differentiation of this streptococcus from streptococcus pyogenes. The conclusion is warranted that streptococcus scarlatinæ, or conglomeratus, is the essential agent of the disease termed scarlet fever.

These researches are confirmed by Bajinski and Sommerfeld, and to a certain extent by Class.

5. Fomites.—In calculating the incubation period of scarlet fever, and in predicting its cessation, the action of fomites in renewing the disease must be incessantly borne in mind. And it is undoubtedly the fact that it is the activity of these fomites, infected at the most infectious period of the disease, which accounts also for many cases where it has been assumed that the convalescent was still infectious, and constituted the cause.

These facts are sometimes forgotten in the case of "return" attacks of scarlet fever, and are omitted in the views of those who assign long periods of incubation to the disease. Murchison cites Hildebrand as catching scarlet fever from his own cloak, which, after exposure to its infection, had been locked up for eighteen months; and adds that if he had put on his cloak at the end of one month, instead of eighteen, after visiting the patient who infected it, and had then been attacked, the case would have been quoted in proof of the possibility of the incubation period extending over four weeks.

6. Independent Origin.—No known case exists of the disease arising *de novo.* It is always dependent upon a previous case.

VI. SYMPTOMATOLOGY.—(i.) *Premonitory Symptoms.*—Scarlet fever, even in its most classical form, is one of the most irregular of diseases. The most perplexing cases are those where the symptoms are too slight to render an accurate diagnosis possible without waiting for the course of events. But the position is not peculiar to medicine, that inadequate data mean suspension of judgment. The most vigilant watching at every stage of the disease is essential to valid decision. One of the cases that caused me great trouble was that of a lad who never felt ill for an hour, went to school the whole time, and where the presence of the malady was only discovered by the peeling of his hands.

There are usually, however, some symptoms of invasion even in slight cases, such as feeling tired, headache, chilliness, aching limbs, and loss of appetite. In more decided cases there occur, in addition, severe headache, thirst, vomiting, and sore throat; while in very young children the onset may be ushered in with convulsions. Occasionally diarrhœa occurs at the commencement. After a few hours of malaise the sore throat, with difficulty in deglutition, becomes a marked symptom. The type of the invasion indicates the nature of the supervening illness. In minor cases the countenance reveals nothing at the beginning of the attack; and in severe instances only the bright eye and sharp expression, incidental to the onset of all diseases, attended with an increase in temperature.

(ii.) *Predisposition.*—The predisposition to scarlet fever is not confirmed as in the case of measles, chicken-pox, and whooping-cough, from which few children escape. In scarlet fever many may never be attacked, however freely exposed; others may avoid it for years and then succumb. For instance, I lived for two years in the midst of the infection and escaped; but a year afterwards I suffered without being able to trace the source.

In a community which has been free from measles for some years the malady, once originated, spreads rapidly, and few escape, notwithstanding every precaution in isolation. The action of scarlet fever is different, and even in a very susceptible community, if care be exercised, one or two cases only may arise.

Poverty and exposure intensify the virulence of the disease, and tend to produce severe sequelæ; while affluence, efficient nursing, and fresh air mitigate the severity and prevent sequelæ in many instances. These conditions, however, have no effect on those who, in consequence of idiosyncrasy, are liable to speedy death from an attack.

(iii.) *Sensations of Illness.*—In slight attacks no apparent illness is discoverable. But I have never seen a case with an intense eruption where the patient was not really, and also felt ill. This symptom is of importance in distinguishing scarlet fever from what I have termed the "Fourth disease," when, however copious the eruption, no appearance or sensation of illness may be perceptible.

(iv.) *Temperature.*—In the mildest type of this illness there is practically no fever, the thermometer rarely reaching 100° F. The average, and the severe type, similarly with the other symptoms of onset, commences with a sudden rise, which continues increasing until the eruption has fully appeared on the third or fourth day, when, if the illness is of a favourable type without complication, the temperature gradually falls. On the other hand, if the more severe type (scarlatina anginosa) is presented, or complications are imminent, the fever continues a longer period. The evening temperature in the benign type varies from 102° to 104° F., or about two degrees higher that that of the morning, and by the end of the week the normal temperature is reached. But in the latter type the temperature gradually assumes the suppurative form with a very high range in the evening and a very low one in the morning, exhibiting a variation of six or seven degrees. This continues until the second week, when, if a favourable turn be taken, the variations gradually diminish down to normal towards the end of the third week. If, however, an unfavourable course occurs from prostration or complications, the excessive temperature is maintained until death. The temperature rises in some cases of scarlet fever to a higher point than in any other eruptive fever. The skin presents the sensation, too, of the most pungent heat.

The temperature in ordinary cases of scarlet fever never increases in the usual ratio with the pulse; that is to say, in scarlet fever there is always a markedly accelerated pulse from the beginning, even where the temperature ascends only to 100° F. And a full rash in scarlet fever always implies a high temperature.

(v.) *Pulse.*—The typical characteristic pulse in every form of scarlet fever, quite from the commencement, is an accelerated one, out of all proportion to the customary ratio with the temperature, and presents considerable tension. This distinguishing feature in mild cases speedily terminates; while in all instances of a severe type it remains. In the ulcerative form we find the suppurative pulse quick, soft, feeble, and attaining 160 to 180. In the malignant type the adynamic pulse full, soft, irregular, uncountable, and becoming gradually imperceptible as the acceleration proceeds.

As convalescence is established the pulse becomes slow, in variation with the previous depressing effect of the scarlet-fever toxin upon the heart muscle.

(vi.) *Tongue.*—If the illness has been of the perambulating variety no indications may be present on the tongue, or, at all events, they may persist for so short a period—which appears to me to be the true doctrine—as to be imperceptible to the medical observer, who may only see the case once, or at most twice, in the twenty-four hours.

But in the ordinary, average, well-marked case the tongue is covered at an early stage with an extensive white coating of epithelium, through which the normal red papillæ protrude, which, peeling off from the tip and edges, has entirely disappeared by the fourth day, leaving a raw-looking, red, fleshy, smooth, swollen condition, commonly termed the strawberry tongue, and absolutely pathognomonic of scarlet fever. As the epithelium is reformed the tongue assumes its normal appearance, though the papillæ, becoming œdematous, sometimes present a miliary aspect. If, however, the fever is high and delirium present, the tongue may grow dry and fissured, though still abnormally red, glazed, and bare of epithelium. In the malignant variety death usually occurs before the tongue peels; and if death takes place prior to the appearance of the eruption, the diagnosis may involve grave difficulty.

(vii.) *Throat.*—1. In the earliest stage of all sore throats the mucous membrane appears smooth, dry, and glistening, as if all secretion and the superficial layer of the mucous membrane had been scraped off and the surface polished.

2. In the next stage of all cases of scarlet fever, even in the mildest, there is a general uniform redness of the uvula, soft palate, the palatine arches, and the tonsils,—in fact, the appearance is that of an exanthem of the throat, exactly analogous to the exanthem of the skin, and precedes the exanthem of the skin by twenty-four hours.

3. When the disease is more intense these parts present a velvet appearance from the œdema which the exanthem of the throat produces. The colour becomes a deeper red, and involves the whole of the fauces and the hard palate. Small elevations form, arising from swelling of the papillæ, which give the mucous membrane a granular appearance.

4. In most cases the preceding condition is succeeded by swelling of the tonsils, which gradually become covered with minute isolated white dots, occasioned, in consequence of the hyperæmia, by an excess of the normal secretion from the follicles of the tonsils.

5. This secretion may increase to such an extent as not only to appear at the orifices of the follicles, but also by coalescence to form a layer of

secretion covering the tonsils, and resembling an ulcerated surface. All the preceding changes usually disappear by the third or fourth day, and the throat by degrees assumes its normal appearance by the end of a week.

6. But when the throat becomes more severely inflamed, as in scarlatina anginosa, the tonsils grow more swollen and ulceration follows, together with an excessive secretion of mucus of an acrid watery character, which includes the whole of the mouth and the nasal mucous membrane, and causes soreness of the nose and the upper lip. Sloughing and gangrene subsequently supervene.

7. At other times abscesses of the tonsils occur, with so extensive a swelling of the uvula and tonsils that regurgitation of fluid takes place through the nose.

8. At a later stage the regions of the parotid, of the submaxillary glands, and the whole of the connective tissue of the neck, become enormously swollen, assuming a brawny character which may disperse in a few days, or terminate in abscesses or gangrene.

(viii.) *Glands.*—It is an invariable law of nature that augmented action produces increased growth. Where additional work is thrown upon glands they become either temporarily or permanently enlarged. In scarlet fever two sets of glands are involved owing to the anatomical lesions which affect them.

1. In common with all eruptive fevers, the glands in relation with the lymphatics of the skin, while performing their functions in connection with the eruption of scarlet fever, become somewhat increased in size. Where the eruption is slight and transient they cannot be detected at all; but where it is copious they are readily perceptible, though they never attain the size, hardness, and tenderness which they exhibit in rubella.

2. The lymphatic glands of the throat and neck can be scarcely perceived during the first few days, although from the onset some fulness of the neck may be discerned; but subsequently an enlargement will occur in proportion to the severity of the faucial affection. In all cases of scarlatina anginosa, where the stress of the illness is largely manifest in the throat, these glands suffer from a severe adenitis frequently attended by suppuration,—the acuteness of the inflammation involving the connective tissue of the neck in a brawny swelling, whence suppuration is also liable to arise,—the thin ichorous matter burrowing in various directions, with the production of sloughing of the connective tissue and the skin, and terminating fatally before the close of the second week. In some instances venous hæmorrhage from the involvement of a vein precedes death.

(ix.) *Eruption.*—I have purposely hitherto withheld the description of this symptom, since, in the investigation of eruptive fevers, the "rash" is usually observed first, and a mental diagnosis is at once made, without a full investigation of other equally important symptoms, and the period of incubation. This entails a preconceived idea that can only betray the investigator into frequent mistakes, which would be avoided if a patient, painstaking investigation of the whole of the symptoms were instituted prior to a definite conclusion. The mind must be biassed which sees the eruption first. For it is an ingrained prepossession in the medical mind, that a diffuse red rash, followed by desquamation, affords unmistaken evidence of scarlet fever. This notion, however, is contrary to fact, as unfortunately the rash of the Fourth disease resembles so closely that of scarlet fever, that, in certain cases, and in certain stages, no medical man who simply studies the eruption can possibly perceive the distinction.

Another frequent source of error in diagnosis is the inference that the slightness of the illness precludes the suggestion of scarlet fever; while its severity is assumed to be an unfailing indication of that disease. It is certain, on the contrary, that some of the mildest cases of serious illness I have witnessed have been scarlet fever; and it is an established fact that these cases frequently become fatal in consequence of acute nephritis. I have also known the illness occasioned by the Fourth disease assume a somewhat severe type.

In the mildest type of scarlet fever the rash is scarcely visible, forming as it does a mere diffuse scarlet blush, which is so evanescent in character, lasting only a few hours, as to have totally disappeared before the visit of the doctor.

It is usually stated that the eruption of scarlet fever is shown first upon the neck, cheek, and upper arms, and that it does not appear upon the face. But I can testify that the eruption does present itself on the face, less raised in character, perhaps; and from its appearance behind the ears, too, I have little doubt that it also occurs on the hairy scalp. I should say that it commences on the scalp, extends to the face, neck, chest, and gradually downwards over the whole of the body. In further evidence of this statement, I would cite that the earliest desquamation is perceptible on the tips of the ears and on the prolabium of the lips. Certainly the eruption is visible on the forehead and cheeks, while the circle round the mouth stands out white in contrast, and the former regions, in addition, shed a browny desquamation.

The sore throat commences with the other symptoms of invasion. The eruption appears twenty-four hours later, spreads rapidly from above downwards, except on the palms of the hands and the soles of the feet, and attains its maximum in three days, when desquamation begins in the same order of process.

The aspect of the eruption from a distance is that of a diffuse, bright brick-red, assuming a darker dusky red when the eruption is intense. On close inspection, however, or with the aid of a magnifying-glass, it is seen to consist of aggregated red papules or pin-heads, with the intervening circles of skin of a normal colour in the first instance, transformed later into an erythema which disappears earlier than the red papules. The papillæ are more raised on the outer surfaces of the limbs, where the skin is naturally thickest, than elsewhere. It is the close aggregation of these papillæ which gives the rash a uniform red appearance, the colour varying from a pale red to a brick red, and the depth of colour being usually in direct proportion to the intensity of the fever. The colour can be pressed out of the skin by the pressure of a finger, and writing with the finger-nail on the skin depicts it in white lines. Hæmorrhagic points appear sometimes in very intense eruptions, and even gangrene. The hyperæmia of the papules may also sometimes entail a miliary eruption, appearing chiefly on the hands and wrists, arising from exudation of serum within the papules. When the skin begins to act, sudamina even may supervene. When the eruption attains its height, œdema of the skin also occurs.

At the termination of the eruption, which takes place in about a week, the skin assumes a yellowish appearance prior to desquamation.

After death no eruption is visible, though, in consequence of exudation in the rete Malpighii, the skin is found to be thickened.

(x.) *Desquamation.*—The hyperæmic condition of the skin, arising from the scarlet-fever eruption, entails an excessive growth of newly-formed epidermis which, on the subsidence of the exanthem, exfoliates, and consequently varies in amount and extent according to the intensity of the eruption. In very thin skins, and in instances where the eruption has been very transient, the peeling would naturally be slight. In these cases I have rarely failed to find it on the tips of the ears and the prolabium of the lips. If the eruption has been severe, peeling commences early on those parts where the eruption first fades; follows the fading immediately; and spreads, in the same order, over the whole of the body. If, however, the eruption has been very scanty, peeling may not be visible anywhere save on the palms of the hands and the soles of the feet, and does not commence in those parts until late.

The desquamation varies in duration according to the preceding eruption, and is usually complete within six or eight weeks, except on the palms and soles, where its cessation is frequently delayed for ten or twelve weeks. The desquamation also varies in extent according to the consistence of the skin in the various regions of the body. When closely observed it is found that desquamation begins around the raised points of the eruption, leaving a hole for the papilla in the centre. These circles coalesce, and the epidermis is shed, varying in character (according to the antecedent eruption, and the region from which it is cast) from a fine powder to shreds and sheets of considerable size, and in the region of the fingers and toes the shedding sometimes occurs in one piece like the finger of a glove. Partial peeling may take place a second time, and so prolong its period.

(xi.) *Digestive System.*—In addition to the vomiting the bowels become early confined, and diarrhœa also succeeds.

(xii.) *Nervous System.*—In slight cases the nervous system is unaffected, but when the attack is severe the delirium, restlessness, and sleeplessness are very marked, and indicate that the nervous system is profoundly involved by the toxin. Ushered in with convulsions, the convulsions may recur, muscular tremors arise, and coma supervene with hyperpyrexia.

(xiii.) *Urinary System.*—The urine during an early period of the illness presents a character similar to that attending an acute fever with a diminution, or absence of chlorides.

Apart from acute nephritis, which will be discussed under the sequelæ, albuminuria is not infrequent, and occurs occasionally in the first week; usually, however, it does not appear until the third week, and most commonly on or about the nineteenth day, disappearing, in a few days, or as the fever subsides. The persistence of albuminuria for a month or six weeks constitutes a very unfavourable symptom.

(xiv.) *Respiratory System.*—Where chest symptoms suddenly present themselves during scarlet fever, it is not the lung that suffers, but the serous membranes of the pleura and the pericardium—except when acute nephritis occurs, in which case pulmonary œdema is to be expected, and is an ominous symptom.

(xv.) *Generative System.*—There is also, at times, a mucopurulent discharge from the vagina, which, during its continuance, may be a source of infection, and should be watched for.

VII. Varieties.—For convenience of description, and without assigning any fixed lines of demarcation, we may distinguish these varieties, and divide them in the following classes:—

(i.) *Scarlatina Simplex.*—The cases included here are those which are attended by slight sore throat; a characteristic eruption; an increase of temperature, perhaps reaching 102° F.; and a quickened pulse, of 120 to 130. The fever reaches its height on the third or fourth day, and the entire illness is comprised within about a week, without complications.

(ii.) *Scarlatina Anginosa.*—This mostly affects young children. It is attended by an ulceration, commencing in the tonsils, which extends and destroys the neighbouring tissues, with symptoms of septicæmia. An intense eruption accompanies it, which becomes dusky, or even hæmorrhagic. The temperature attains 104° F. or upwards. The pulse becomes very rapid, 150 or 160, and irregular.

These symptoms continue into the second week, attended with delirium, insomnia, and anorexia. Unless improvement here supervenes the disease proceeds into the third week accompanied by diarrhœa, sweating, pulmonary symptoms, and death.

(iii.) *Scarlatina Maligna.*—The severity of these cases results from the production by the toxin of acute poisoning in the blood, which is followed by death within twenty-four or forty-eight hours, before even local manifestations have had time to arise. The absence of symptoms, together with the rapidly fatal result, may give rise to suspicion of the action of an external poison. There may be no rash, no local affection of the fauces, but the intensest fever, 106° F. or upwards, with an uncountable pulse. Sometimes the nervous depression is so profound that the temperature is subnormal. In less severe cases of an adynamic type the rash and throat are evident, and the patient may live for two or three days longer.

(iv.) *Scarlatina sine Eruptione.*—These are abortive attacks of scarlet fever characterised by their mildness and the complete absence of certain symptoms, such as the rash in some instances, and in others the throat signs. In scarlatina sine eruptione there is occasionally found a well-marked and extensive desquamation.

(v.) *Scarlatina sine Anginosa.*—In this form rheumatism, kidney disease, parotitis, and infiltration of the cervical connective tissue, may even occur.

(vi.) *Surgical scarlet fever* ensuing upon wounds, however caused, is generally of a mild type.

(vii.) *Puerperal scarlet fever*, arising immediately before or after parturition, usually presents a form which causes grave anxiety by reason of its fatality, with septicæmic symptoms. At anterior stages the pregnant woman is not more affected by scarlet fever than persons generally.

VIII. Stages.—(i.) *The Period of Incubation.*—If one fact be more certain than another in medicine, it is the limitation of the incubation period of scarlet fever to seven days. In cases where the term is stated to exceed this limit the accurate source of infection has been mistaken, or the cases belong to the class of disease which I have designated a "Fourth disease," and which it is exceedingly difficult to differentiate from scarlet fever.

It is undoubtedly the fact that in occasional instances the period of incubation is less than twenty-four hours; but the greatest number of patients exhibit the disease on the third day, many on the second or fourth, a few on the fifth, while its occurrence on the sixth is extremely rare. It may be regarded, therefore, as final doctrine that the incubation period of scarlet fever never extends beyond a week, and rarely lasts so long. But in estimating the period of incubation it must be remembered that during a time when scarlet fever is prevalent the common sore throats of colds, or cases of simple tonsillitis, occurring in those who have suffered from scarlet fever, are capable of conveying scarlet fever to an individual who has not already been affected. If the patient has been previously attacked these sore throats are regarded as non-infectious, and the sufferers consequently are not isolated, as they should at once be, for three or four days. The interpretation of these cases appears to be this:—There are always a certain number of young people in every community who have tonsillitis several times in the course of the year; and even when they do not suffer from an acute attack, the tonsils are chronically enlarged and full of accumulated secretion, in which the scarlet fever bacillus finds a suitable nidus for development; while, accordingly, the sufferers are themselves protected, the bacilli are able to fertilise and infect the unprotected. I believe that precisely the same process takes place in the causation of "return" cases of scarlet fever. Fresh cases of infection are mixed with convalescents whose throats, not yet restored to a normal condition, provide the congenial soil for a new invasion of active bacilli, and when these convalescents return home the natural result follows which defeats the force of isolation. When scarlet fever is becoming prevalent I carefully isolate *every* case of sore throat, however slight, and consequently an epidemic has never occurred. I endeavour, moreover, to prevent a recent case being placed near a convalescent, and thus I have never experienced a "return case," although I have allowed boys to return to school or to their homes with impunity. It is further suggested by some authorities that some sore throats, produced solely by exposure to the infection of scarlet fever, are capable of inducing the disease in what are termed second attacks. It may be so: I cannot assert the contrary. But I am quite sure of my previous interpretation, knowing well the facts of those cases which were affected with the oft-repeated tonsillitis, and which caused me trouble.

(ii.) *The Period of Infection.*—Of all zymotic diseases scarlet fever is the least infectious in its early stage. Were it not for this fortunate feature in its natural history it would probably spread as freely as measles or rose-rash. Its most infectious period is undoubtedly during the height of the eruption, with a gradual diminution as the illness wanes. At this stage its powerful capacity of infection is evidenced by the cases occasionally recorded where not only a moment's exposure has sufficed to produce infection personally, but even where a mother, after the briefest exposure, has, without being herself affected, conveyed infection to her child at a distance. In such cases I believe that the sick-room must have formed a hot-bed of infection from the absence of a free supply of fresh air.

The question, however, of deepest concern is the duration of the infection. One course only is sound and sure in our present state of knowledge. In slight cases six weeks' quarantine should be imperative; in all other cases freedom from infection should not be certified until all desquamation, all discharges from the eyes, nose, mouth, throat, and abscesses has ceased. It is questionable whether the prolonged period of persistence of infection which is sometimes assigned is not really due to fomites.

Although I have expressed the only safe rule of action, I am far from believing that the duration of infection is at all as extensive as that which is ascribed. I am of opinion, though demonstration is not available at present, that in an average case of scarlet fever without complications, supplied throughout with abundant fresh air, free from contact with recent cases, and with a thorough disinfection of person and clothes, the infection does not endure for half the time we usually assign. I submit the proposition, with clear conviction, that, where disinfection has been complete, and no fomites are present, the prolonged peeling from the hands and feet is not infectious.

When, however, we consider the question of fomites we are struck by the tenacity of infection. Without doubt the disease is readily and frequently conveyed by fomites, and thus all calculations become frustrated. Disused infected rooms, disused clothes folded up in drawers, and long-forgotten toys have caused scarlet fever to start *de novo* months after the previous illness.

With reference to the *recrudescence* of scarlet fever I am not quite clear that such a process occurs. Nor am I now certain that a *relapse* ever takes place. In former years I thought otherwise; but having of late years attended (and studied those of other observers) cases of scarlet fever preceded and followed by a distinct disease, closely resembling scarlet fever, which I have provisionally designated a "Fourth disease," I am seriously dubious of the recrudescence theory.

(iii.) *The Period of Protection, or Immunity from further Attacks.*—Fortunately one attack, as a rule, confers immunity for life. Where second attacks are recorded, I believe that usually they belong to the species of the "Fourth disease" (p. 503). There are certain rare individuals, however, who are so susceptible to the influence of the poison that they will exhibit some of the symptoms in every conceivable anomalous form whenever they come in contact with the disease. I had one patient who was thus afflicted. Similar instances are found in small-pox. A patient of mine had been inoculated for small-pox; had suffered from confluent small-pox; had been subsequently vaccinated, and yet eventually died of small-pox poisoning at the age of seventy-five, without eruption, caught from one of his parishioners with whom he sat reading. On the twelfth day acute fever showed itself, with severe backache, and on the ninth day of a severe illness, attended with delirium, he died. Such instances, however, are so rare as to be unique.

IX. COMPLICATIONS.—The complications of scarlet fever are numerous and various, and even when not fatal, they frequently entail permanent damage upon organs, or life-long ill-health. No period of the disease is free from complications. At one time they arise suddenly, at another their advent is too insidious to attract notice.

(i.) *General Diseases.*—Rheumatism forms one of the earliest and most frequent complications. It affects chiefly the smaller joints, such as the fingers, hands, and wrists; suppuration is sometimes produced in the joints. Its appearance usually occurs during the first week, and elder children and adults rather than young children are affected.

(ii.) *Diseases of the Nervous System.*—Scarlet fever is frequently complicated with severe central and spinal symptoms which may arise from hyperæmia, or blood-poisoning, or meningitis.

(iii.) *Diseases of the Digestive System.*—1. Ulcerative Stomatitis.—In all descriptions of scarlet fever, when complications appear, their tendency is to assume ulcerative and pustular forms. After an attack of the mildest type of scarlet fever I have seen ulcerative stomatitis supervene. From the condition of the throat in scarlatina anginosa the inflammation spreads to the mouth; the gums become spongy, bleed easily, and ulcerate. In severe cases the inflammation proceeds to NOMA, with all its attendant symptoms of salivation, sloughing, and the shedding of the teeth; and confines itself to young children entirely. From the resulting exhaustion, and the pain in taking food, sufficient nourishment is impracticable, and great debility thus ensues.

2. Liver.—Changes in the condition of the liver are also present, consisting of an albuminoid infiltration of its secreting cells, produced simply by the severity of the fever.

3. The *intestinal* mucous membrane becomes intensely congested, and occasions severe diarrhœa.

(iv.) *Diseases of the Circulatory System.*—Pericarditis and endocarditis are occasionally present, with or without rheumatism; and those changes in the cardiac muscle where the fibres assume a granular opacity, which form the usual result of high fever. Thrombosis is not unusual, and results from septicæmia. The blood is of a dark colour, watery in character, with an excess of white corpuscles.

(v.) *Diseases of the Respiratory System.*—Bronchial catarrh and pneumonia are not uncommonly found on search, especially in cold weather. Œdema of the larynx, and acute pulmonary œdema, when the kidneys are involved, are especially to be dreaded.

(vi.) *Diseases of Serous and Synovial Membranes.*—Effusion into the pericardium, pleura, and joints is very liable to occur. It supervenes insidiously, and tends to terminate in suppuration.

(vii.) *Diseases of the Urinary System.*—1. Albuminuria.—As shown in a daily examination of the urine in each case, simple albuminuria, usually without casts, may commence as a mere trace during the first few days, and generally speaking implies little importance—in fact it frequently means improper feeding in the early stage of scarlet fever, or unwise exposure.

But it most frequently arises in the same character during the third week—about the nineteenth day—and, unless very marked in quantity, gradually disappears as convalescence proceeds. In some instances it is not manifested until the patient leaves his bed. Most generally it occurs when constipation exists, and, where it persists, a prolonged period in bed may be required before its final disappearance.

2. Acute nephritis is usually occasioned by the toxic effect of the scarlet-fever poison, though sometimes it is produced by chill. Its onset is sudden, and is accompanied by headache, vomiting, rigors, acute fever, drowsiness, diminished secretion of urine, frequent micturition in small quantities, hæmaturia, and casts. After a day or two the skin becomes dry, anasarca appears, and the temperature varies. Increased arterial tension is found, with a quick pulse. Mahomed described a pre-albuminuric tension of the arteries. As the hæmaturia lessens all the symptoms abate, and the flow of urine increases.

There is another type of case with similar commencement, but with less marked symptoms, and without hæmaturia. This type usually supervenes towards the end of the third week. It occurs as frequently, if indeed not more frequently, in mild as in severe attacks, in consequence of the former receiving insufficient care. It either terminates in recovery, or leaves permanently damaged kidneys, or ends in death from uræmia or acute pulmonary œdema.

(viii.) *Diseases of the Organs of Special Sense.*—1. The Ear.—Unless there be a family predisposition to *otitis*—which, in my experience, is very frequent even in those in affluent circumstances, and very disastrous in its consequences—its occurrence is usually manifested in severe cases only. It generally presents itself during the first five years of life, decreases in each subsequent year, and forms the most frequent complication of scarlet fever. Otitis, in these instances, is commonly an extension of the faucial inflammation; varies from a simple earache to an acute otitis media, and may be followed by mastoid abscess, and even meningitis. Subsidence may take place within a few days or weeks; or its duration may be extended for months or even years.

2. *The eye* is rarely involved, and then only with a slight conjunctivitis in the early stage. But in the delicate and cachectic the eyes may be seriously implicated during the suppurative period in a general ophthalmia,

with corneitis, where the home surroundings are those of destitution and overcrowding; and with retinitis when the kidneys are involved.

(ix.) *Diseases of the Lymphatic Glands.*—In addition to the state of the glands previously described as occurring during the height of scarlet fever, suppuration of the cervical glands may ensue during convalescence.

(x.) *Diseases of the Supporting Tissues.*—1. *Cellular Tissue.*—Inflammation of the greater part of the areolar tissue of the neck and parotid region may occur, tending to suppuration which may burrow in all directions, and produce formidable abscesses, or sloughing of tissues.

2. *Bones.*—Periostitis and necrosis may arise at a later stage of the disease.

(xi.) *Diseases of the Integumentary System.*—An infinite variety of affections of this system may be produced, ranging from herpes labialis to severe boils. The most frequent is eczema, which mainly occurs at those orifices from which acrid or pustular discharges have flowed—round, for example, the ears, nose, and mouth. The inflamed oozing eczema is apt to become pustular, and to extend from these centres.

(xii.) *Anœmia* and a protracted period of general debility and ailing are often the sequelæ of a slight attack in the delicate, or of a severe attack in the strong, and require attention for months or years before the usual health is recovered.

X. Relation to other Diseases.—(i.) *Measles.*—It has been stated by some medical writers that scarlet-fever epidemics tend to follow outbreaks of measles; but this view, after a lengthened and carefully analysed experience, I am unable to endorse. The relation, however, which has been observed between scarlet fever and measles is completely explicable where rubella and the Fourth disease are substituted. These forms of disease are so frequently concurrent or consecutive that their confusion with measles and scarlet fever, or with rubella and scarlet fever, is both prevalent and facile.

(ii.) *Diphtheria.*—Although diphtheria may occur at any stage of scarlet fever, its prominent period of appearance is that of convalescence. It may follow the mildest as well as the severest form of scarlet fever, and seems to be incidental to cases treated in hospital, where it apparently clings to certain hospitals and certain wards. When it occurs it usually arises in groups of cases in the various wards which possess no intercommunication. Dr. Caiger, whose special experience has been most extensive, says:—"Such outbreaks have not infrequently arisen in seasons characterised by a high degree of atmospheric humidity, dependent upon previous rainfall and consequent dampness of soil. The incidence of the disease is for the most part greatest in wards surrounded with grass, or other vegetation growing in a clay soil; indeed, the moisture-retaining character of the actual surface would seem to be of greater importance than the subsoil drainage, whether natural or artificial." He furnishes the mortality in cases of diphtheria following scarlet fever as 58·3 per cent; and this high percentage is due to the special tendency of the disease to affect the respiratory passages.

Scarlatina from diphtheria may at any time arise; but this course is rarer than the reverse one.

XI. Diagnosis.—From the preceding discussion it will be readily understood that this disease presents the most serious difficulty in diagnosis. In its mildness or in its infinite vagaries many days may elapse before a definite judgment can be formed; and at times, indeed, the certainty of diagnosis may appear to be impracticable, unless another case arises from it with an accurate period of incubation and well-marked symptoms. Even in typical instances I have myself long felt doubtful until some days have elapsed, and characteristic symptoms have appeared in their natural course. In face of these difficulties, and in regard to the serious consequences which may ensue from erroneous diagnosis, I would suggest that the only sound rule is that of the game of whist,—"When in doubt play trumps"! and hence I propound the maxim that the existence of doubt should imply the presence of scarlet fever, on the ground that, if the assumption prove incorrect, less harm will usually have been produced by reason of the scrupulous care that will thus have been exercised. This course, however, is not always justified; for a medical friend not long since informed me that twenty-eight patients had been sent to a scarlet fever hospital in one year, the whole of whom proved to be free from that disease. I have also a series of cases in my hands, recorded by a most accurate observer, but I am unable to make use of them now, beyond saying that six patients were admitted into a fever hospital as scarlet fever who were proved to be suffering from the Fourth disease, and subsequently caught scarlet fever when in hospital; and six other patients were admitted suffering from scarlet fever, who caught the Fourth disease while in hospital from some of the previous set.

In presence of such grave mistakes a serious burden of responsibility is involved in the accurate diagnosis of these cases of illness, but still more so on one who presumes to instruct others in their elucidation.

In now considering the question of diagnosis, I would urge, *in limine*, that the physician who bases his diagnosis primarily upon the "rash" is hopelessly lost in confusion. I even venture to make the wider statement, that a physician who commences his investigation of these exanthemata by observing the rash chiefly, is involved in the same confusion, since, in the interpretation of the remaining symptoms, he will become so biassed by his foregone conclusion that no clear judgment will be practicable.

In a typical case of scarlet fever diagnosis is comparatively easy, and for the purpose of refreshing the memory I will briefly enumerate the symptoms. A sudden onset of acute symptoms, with headache and vomiting, accompanied by a marked sore throat, attended by high fever and an exceedingly quickened pulse, followed in twenty-four hours by a minutely punctate eruption, which avoids the circumoral region, and spreads from above downwards until the entire body is uniformly covered. The tongue peels on the fourth day of the illness, which is followed by a general desquamation of the skin from above downwards, commencing on the face, lips, and ears. With this series of symptoms before him even the comparatively inexperienced can find no difficulty in diagnosis.

The diseases with which scarlet fever is mostly confounded must now be considered:—

(i.) *Acute Tonsillitis.*—In the early stage of this disease, and when scarlet fever is prevailing, accurate diagnosis is well-nigh impossible, and therefore quarantine is imperative. The disease, however, rarely commences suddenly with vomiting; the eruption, when present, is merely an erythema, and not a punctate eruption. At first the tonsillitis is unilateral. The tongue, though coated, does not peel, and the skin does not desquamate.

(ii.) *Erythema.*—At an early period, when diagnosis is of most importance with a view to isolation, the rash in these cases is limited to the neck and a portion of the trunk; it does not appear on the extremities, and it spreads in a very irregular manner.

(iii.) *The Fourth Disease.*—Provisionally merely *numbered*, until a distinguishing name is attached to it.

Definition.—A zymotic disease characterised by an exanthem, scarlatiniform in character, which is usually the first noticeable symptom. It is a diffuse, not patchy, rosy-red eruption from the onset, and, however intense the eruption may be, the sensation of heat to the touch is usually slight. It is generally followed by desquamation, which bears, however, no relation to the intensity of the eruption.

It is mostly preceded by no symptoms, though where the attack is sharp there may be some headache, drowsiness, and tiredness for a few hours before the eruption is manifest. Its season is mainly the spring. The incubation period prolonged even to three weeks. Its duration of infection is about a fortnight. The strawberry tongue is never present. It affords no protection against measles, scarlet fever, or rose-rash.

History.—It was not until towards the close of the seventeenth century that scarlet fever ceased to be confounded with measles, and at the close of the nineteenth century rose-rash (rubella) was still confused with measles and scarlet fever. At the opening of the twentieth century another disease has been distinguished, isolated, and classified, which, while greatly resembling measles, rose-rash, and scarlet fever in many characteristics, is quite distinct from them all, and an attack of any one of these diseases does not protect from an attack of the other.

Etiology.—Enough is not known at present to speak of the age and sex incidence. But the various epidemics I have seen occurred in December, February, March, April, and one single case in June. It is an infectious disease which, like scarlet fever, occurs in smaller epidemics than measles or rose-rash, probably on account of its being, again like scarlet fever, less infectious at the outset.

Symptomatology.—See pages 503-507, where its distinguishing characters are set out side by side with those of scarlet fever and rose-rash. Also the original article may be consulted in the *Lancet* of July 14, 1900, "On the Confusion of Two different Diseases under the name of Rubella (Rose-rash)," and a paper by the medical officer of health for Southport, "On the Fourth Disease," and published in the *Journal of State Medicine.*

To sum up the leading characteristics which show that this disease is distinct from measles, rose-rash, and scarlet fever, I will formulate them as follows :—

1. That although the resemblance of the Fourth disease is so close to scarlet fever in many of its features, it cannot possess any affinity with that disease, inasmuch as both diseases occurred concurrently in the same epidemic.

2. That some of the sufferers had BOTH diseases in the same epidemic, one patient having scarlet fever followed by the Fourth disease, and several having Fourth disease followed by scarlet fever.

3. That, although the Fourth disease has been confused with rose-rash, and regarded as a mere variety of rose-rash, this conclusion is fallacious, since nearly one-half the cases in one of my epidemics had already had rose-rash within a year or two, which, according to Cullen's established law, is incredible.

(iv.) *Rubella.*—*Vide* p. 465.

THE DISTINGUISHING CHARACTERISTICS BETWEEN RUBELLA (ROSE-RASH) THE "FOURTH DISEASE," AND SCARLET FEVER.

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
1. *Premonitory Symptoms.*—In many instances none ; no headache ; no vomiting ; no catarrh ; no cough ; but frequently sore throat. If the attack be severe, some malaise, anorexia, and drowsiness will exist.	1. *Premonitory Symptoms.*—In many cases none, even with a copious eruption ; neither headache, nor vomiting, nor catarrh, nor cough, but frequently slight sore throat. If the attack, however, be severe, there may be pronounced malaise for some hours, with headache, anorexia, drowsiness, chilliness, and even considerable backache.	1. *Premonitory Symptoms.*—If the attack be slight the patient merely feels tired, and usually complains of some amount of sore throat, headache, and chilliness. There may, however, be considerable malaise, with a genuine sense of illness, accompanied by some vomiting.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*Continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
2. *Sensations of Illness.*—Even with a full eruption as intense as in measles the patient usually states that he does not feel ill, although there may be other indications to the contrary.	2. *Sensations of Illness.*—Where the eruption is slight there is no illness of any kind, and where the eruption is copious the feeling of illness is sometimes scarcely apparent, although I have seen boys really ill from this disease.	2. *Sensations of Illness.*—In slight cases there is no apparent illness, but I have never seen a case with a severe eruption where the patient was not really, and also sensibly, very ill.
3. *The Temperature.*—This varies from normal to 103° or 104° F.	3. *The Temperature.*—This varies from 98·4° to 103° or 104° F.; but even with a very extensive rash the temperature is not necessarily high.	3. *The Temperature.*—This varies from 99° to 106° F., but is never increased in the usual ratio to the pulse. A full rash always means a high temperature.
4. *The Pulse.*—This is normal or slightly increased in frequency, but always bearing a ratio to the temperature.	4. *The Pulse.*—In slight cases the pulse is normal, and where the case is a well-marked one its rate is quickened, while still bearing a ratio to the temperature; that is to say, where the pulse is accelerated the temperature is raised in a proportionate degree.	4. *The Pulse.*—Even in slight cases the pulse is accelerated, and in severe cases very greatly quickened, and always out of all proportion to the height of the fever; that is to say, even with a temperature only just above normal (99° F.) the pulse will be very rapid (120).
5. *The Tongue.*—This is clean or slightly furred, and never coated with a thick white fur, which peels on the fourth day.	5. *The Tongue.*—The tongue is clean or slightly furred, and never coated with a thick white fur, which peels on the fourth day, leaving the tongue raw.	5. *The Tongue.*—If the case be slight there may be no early signs, though the tongue peels on the fourth day. But in a well-marked case the tongue is early coated with a thick white fur which, peeling off from the tip and edges on the fourth day, gradually leaves a raw, red tongue, commonly termed the "strawberry" tongue
6. *The Throat.*—The fauces look dry, with a dark, motley, red hue.	6. *The Throat.*—The fauces are usually swollen and reddish, assuming a velvet appearance, but this condition bears little relation to the extent of the rash.	6. *The Throat.*—The appearance of the fauces may vary from the most insignificant affection to an intense dusky redness, with marked swelling, showing sometimes white spots of inspissated secretion; and the severity of the throat affection bears usually a distinct relation to the skin eruption.
7. *The Glands.*—The lymphatic glands throughout the body are enlarged, tender, and hard, like peas, notably the posterior cervical, the axillary, and the inguinal.	7. *The Glands.*—The lymphatic glands universally are enlarged, hard, and tender, and feel like peas, though less manifest than in rose-rash. Those mainly affected are the posterior cervical, the axillary, and the inguinal.	7. *The Glands.*—The lymphatic glands of the throat and neck can scarcely be detected during the first few days; but subsequently they may be enlarged in proportion to the severity of the faucial affection. This, however, creates no difficulty, as the axillary and inguinal glands are not so involved as in rose-rash.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*Continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
8. The *eruption* is usually the first noticeable symptom. Its appearance is that of minute rosy red dots, not patches. It shows itself first behind the ears and on the scalp and face, especially on the oral circle; from these situations it extends to the neck and the chest, and ultimately covers the entire body. The minute dots become larger and gradually coalesce, forming patches of the bat's wing pattern, which so extend and alter in colour as to be indistinguishable from measles. In other cases the spots become so diffused that the rash, in patches, resembles the eruption of scarlet fever; but never, in this disease, is this appearance manifest from the commencement.	8. The *eruption* is usually the first noticeable symptom, and will cover the whole body with a considerable diffuse rash in a very few hours. The hue is a bright rosy red, and the eruption is raised somewhat from the surface of the skin. The sensation of heat of the skin to the touch, even where the rash is very full, is much slighter than in scarlet fever.	8. The *eruption* is diffuse, dusky red, papular in character, and originates behind the ears. It presents a goose-flesh appearance. It does not occur in isolated dots at any stage; nor in patches which are raised and have well-defined margins. It appears early about the clavicles and on the chest and the covered parts of the body. The rash is rarely so full at an early period as in the "Fourth disease," and the skin is markedly burning to the touch.
9. *Desquamation.*—There may, perhaps, be a little branny desquamation, but frequently none occurs, and certainly the pin-hole description is not found.	9. *Desquamation.*—The desquamation may be slight, or as complete as possible, even extending to a general peeling of the hands and feet. But the desquamation bears no relation to the intensity of the eruption, for it often happens that a very full eruption may be followed by little or no desquamation, and that which does occur disappears in a week or two. On the other hand, a full eruption may be attended by a general peeling as free as in the worst cases of scarlet fever, but mostly in small scales rather than in flakes or sheets. A slight rash is usually accompanied by little or no desquamation. But I have never seen a case of scarlet fever with a full eruption where the desquamation did not occur eventually in sheets, the process lasting many weeks. If a series of cases be observed, these abnormalities will be very apparent.	9. *Desquamation.*—The desquamation always bears a ratio to the extent of the eruption. A copious eruption signifies a free desquamation, while a scanty eruption is followed by a sparse peeling, which, however, does not cease for many weeks. It commences invariably by a peeling of the tongue on the fourth day, which extends to the lips and is followed by peeling of the face and behind the ears; one of the easiest places in which to detect the desquamation early is the ear. The desquamation occurs in pieces or shreds rather than scales, and is very profuse about the hands and feet, lasting for many weeks. At the commencement of the peeling circles of desquamation are formed around the raised papillæ, though I have once seen this condition in the "Fourth disease" where the peeling was excessive.
10 *The Kidneys.*—They are rarely affected, and then only with a trace of albumin.	10. *The Kidneys.*—These are rarely affected. Where they are involved the condition is probably that only of the albuminuria of adolescents.	10. *The Kidneys.*—Albuminuria is very frequent. The liability to acute nephritis is very decided unless the treatment be appropriate.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*Continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
11. *The Eyes.*—The conjunctivæ are pink red and suffused.	11. *The Eyes.*—The conjunctivæ are pink and suffused.	11. *The Eyes.*—Normal.
12. Its *season* is spring and summer.	12. Its *season* is spring and summer.	12. Its *season* is autumn and winter.
13. The *incubation period* is usually 18 days, but with a range of from 9 to 21 days.	13. The *incubation period* has a probable range of from 9 to 21 days.	13. The *incubation period* is usually from 2 to 3 days, but with a range from a few hours to 7 days; it very rarely extends over the fifth day.
14. *The Course of Illness.*—The symptoms, however severe, disappear in a few days, leaving comparatively little feeling of illness · where the eruption is slight there may be no illness whatever.	14. *The Course of Illness.*—The symptoms, however severe, disappear in a few days, leaving comparatively little feeling of illness.	14. *The Course of Illness.*—The illness gradually subsides in from 4 to 7 days. Desquamation commences as eruption fades, and continues for 6 or 8 weeks or more, and lasts longest on the hands and feet.
15. *The Period of Infection.*—I do not know any illness which is more infectious in its earlier stage, even before any symptoms are manifest. It hence results that schools suffer to so great an extent from the disease when once it has found entrance. The infection is diminished at a later stage.	15. *The Period of Infection.*—Infection is not very probable in the earliest stages. At a later period, even while desquamation is taking place, the possibility of infection only continues for 2 or 3 weeks, provided the usual precautions have been carefully adopted.	15. *The Period of Infection.*—This disease is the least infectious of any illness during its early stage. It therefore allows time for quarantine and isolation, and thus can be controlled, so that an epidemic may be prevented more readily than in any other infectious illness. After the first 48 hours the infection is very powerful, but I am not prepared to pronounce upon its duration. Until this can be ascertained the only safe rule is the assumption that it may last as long as desquamation itself, although I am quite clear that this is inaccurate.
16. *Protection.*—The attack affords no protection against measles, the "Fourth disease," or scarlet fever.	16. *Protection.*—The attack affords no protection against scarlet fever or rose-rash.	16. *Protection.*—An attack affords no protection against the "Fourth disease" or rose-rash.
17. *The Duration of Infectiveness.*—From 10 to 14 days where efficient disinfection is in force.	17. *The Duration of Infectiveness.*—From 10 to 14 or even 21 days where efficient disinfection is carried out.	17. *The Duration of Infectiveness.*—From 6 to 8 weeks or more, *i.e.* when the desquamation has ceased. But I am far from believing that the infection endures so long after efficient disinfection, though at present I can adduce little proof.
18. *Sequelæ.*—Practically none.	18. *Sequelæ.*—Practically none, but I have seen the submaxillary glands enlarged.	18. *Sequelæ.*—Nephritis; suppuration of the submaxillary lymphatic glands and others; otitis; rheumatism; endocarditis.

Characteristics between Rubella, the "Fourth Disease," and Scarlet Fever—*Continued.*

Rubella (Rose-Rash).	The "Fourth Disease."	Scarlet Fever.
19. *Termination.*—Usually complete recovery in a fortnight.	19. *Termination.*—Usually complete recovery in a fortnight.	19. *Termination.*—Usually complete recovery ensues, but sometimes convalescence is prolonged on account of the sequelæ; but the disease shows a high mortality in the very young.
20. *Treatment.*—The patient requires about 5 days in bed, followed by 3 days indoors; then about 6 days in the fresh air; and after complete disinfection he may safely mix with others. *Abortive* cases of rose-rash are frequent, and are responsible to a large extent for the spread of this disease. It is difficult to distinguish them, as no actual illness occurs. 1. *Pink eyes.*—A group of cases of epidemic roseola may occur, which exhibit no symptoms that I have yet ascertained except pink conjunctivæ. And these cases are capable of passing the illness on to others, and are immune against a subsequent attack themselves. 2. There is another group of cases of epidemic roseola which I believe—but I cannot at present advance beyond belief, for I have not yet satisfied myself by actual proof—may occur without showing any symptoms beyond slight feverishness and enlargement of the lymphatic glands throughout the body.	20. *Treatment.*—The patient may be permitted to get up on the fifth or sixth day, or as soon as his strength permits, irrespective of the desquamation and without danger from sequelæ. He then requires 3 or 4 days indoors, followed by 5 or 6 in the fresh air, and may safely join his schoolfellows at the end of from 14 to 21 days, notwithstanding desquamation, provided the disinfection has been complete.	20. *Treatment.*—Every case of scarlet fever, however slight, requires 21 days of absolute confinement to bed. The patient should be clothed in a flannel night-shirt, and the skin daily greased with carbolic or eucalyptus oil. No food should be given for the first week except milk and farinaceous food, however mild the illness, in order to guard against nephritis. The patient should not be permitted to join his friends for 6 or 8 weeks; but I do not think it essential to isolate cases until all desquamation has ceased from the hands and feet, for this process sometimes occupies several additional weeks. I have acted on this assumption for many years without harm, even transferring boys to their own homes. Of course, complete disinfection is imperative.

(v.) *Measles.*—A universally confluent eruption of measles, which, however, is very marked on the face, and so should not mislead, may exceptionally assume an appearance resembling scarlet fever. But the earliness of the eruption of scarlet fever, without the preceding catarrhal symptoms of measles, and the characteristic tongue of the fourth day, followed by general desquamation, should remove doubt. The presence of Koplik's spots on the mucous membrane of the mouth and palate may also assist in the diagnosis.

(vi.) *Small-pox.*—The sharply defined individual spots, which shade off gradually into an erythema, should guide the diagnosis, but can only induce error at the very early stage. The severe backache of small-pox should further assist.

(vii.) *Erysipelas.*—The distinction on this point lies in the fact that in scarlet fever, besides the other characteristic symptoms, the rash presents the punctate appearance, while in erysipelas the surface of the eruption is not elevated, and marked œdema of the connective tissue arises, with the formation of vesicles. In scarlet fever the desquamation may occur in places where no antecedent eruption has appeared, but this never happens in erysipelas.

(viii.) *Diphtheria.*—Scarlet fever, with a sloughy-looking exudation on the fauces, may be mistaken for diphtheria when accompanied by an erythema of the skin. Here again it is simply an erythema and not a punctate eruption. This, besides being merely transient, is usually restricted to the neck and trunk, while the extremities remain unaffected.

(ix.) *Influenza.*—An erythema may occur at the onset.

(x.) *Desquamative Eczema.*—At the commencement of the illness general symptoms are frequently severe, and the skin red and œdematous, accompanied speedily by minute vesicles, which may resemble a miliary eruption or sudamina.

XII. Prognosis.—The prognosis of scarlet fever is always uncertain. As a rule the disease is one of the mildest of the exanthemata; but its prognosis, even here, is dubious on account of the numerous sequelæ which may supervene and jeopardise life. Alert observation of every sign, therefore, should form the physician's course, and prediction had better be avoided.

The prognosis is *favourable* when the onset is gentle, the appearance of the rash early and diffused; when the throat affection is not severe, the cervical lymphatic glands not seriously involved, the increase of temperature and pulse moderate, and when temperature and pulse fall as the eruption disappears. Slight rheumatism and albuminuria do not add materially to the gravity of the disease.

Prognosis, on the contrary, is *unfavourable* under the following circumstances:—A sudden onset, with vomiting and delirium; severe involvement of the throat, the nose, and the air-passages; a copious rash of dusky red colour passing into a livid hue; when the temperature rises above 104° F., which continues into the third week; a pulse above 130, small and thready; a very pronounced glandular enlargement; severe nervous symptoms, such as coma, convulsions, restlessness, sleeplessness, and continued delirium; profuse vomiting and diarrhœa; the formation of abscesses in the cellular tissue, glands, and joints; acute nephritis, with excessive hæmaturia, albuminuria, scanty urine, and dropsy; the involvement of the serous membranes; severe affections of the middle ear; and the occurrence of that malignant form, with pronounced angina and intense febrile course, which proves fatal, as no other disease does, in so brief a period and with such distressing symptoms.

Epidemics vary profoundly, and no epidemic should be regarded as benign; for, in certain places and in certain individuals, the reverse result is sometimes found. The season appears to exercise comparatively little influence. The only effect which poverty or opulence seems to possess depends apparently upon the medical aid and nursing which can be secured, though personal predisposition outweighs all other considerations. Sex shows no influence, while to age, next to idiosyncrasy, must be attributed the greatest weight. The case-mortality, preceded by symptoms of septicæmia, is increased enormously, attaining over 50 per cent, if the attack occur during the puerperal state, and particularly if it occur close to the date of parturition, either in precedence or succession. Those states of health, too, which are described as "delicate" and "cachectic" exert a most unfavourable influence.

XIII. Mortality.—Scarlet fever is the most uncertain of all zymotic diseases in relation to mortality. Different outbreaks widely vary in this respect. During the last fifty years the mortality has diminished by about 75 per cent, and this diminution is due to various causes. One cause, no doubt, is its lessened virulence; another the provision of isolation hospitals.

But the mainly effective cause has been the increased care bestowed by many parents upon their children at the nursery age, where the mortality has proved to be 18·8 per cent. The number of unprotected children at the school age is consequently greater. Schools, accordingly, suffer more severely from all the zymotic diseases, though the mortality is considerably lessened, the death ratio being only 3 per cent in scarlet fever.

It would be hazardous to predict that the present benign character of this disease will continue, and that a wide and fatal diffusion of the infection at some time may not occur.

The mortality reaches its maximum in the third year, and the chance that an attack will terminate fatally is highest in infancy. The results of statistical inquiry clearly show—independently of the fact that a large proportion of persons never contract the disease—that the longer an attack is deferred the less likely is its occurrence; and further that, even supposing it to happen eventually, the less probable is its fatal character. In recent statistics of mortality it is proved that from one to five years of age the mortality is about 18 per cent; between five and ten years it decreases to 5·5 per cent; and from ten to fifteen years to 2·5 per cent. From this date it remains practically the same until the quinquennium, thirty to thirty-five years of age, when it re-attains a percentage of 6·2.

From the previous description of the mild and severe types of this disease, it must not be inferred that the mortality in the former cases is insignificant, and in the latter frequent; such a deduction is quite unwarranted. In fever hospitals, where the severe cases are found, and mild attacks almost unknown, the inference may hold; but certainly the general truth upon the subject is not thereby expressed. Some time ago, for example, an epidemic of scarlet fever occurred in a neighbouring primary school. On its cessation I asked the master how the children had fared, and whether any deaths had resulted. The answer was "five"; and, on closer questioning, I ascertained that in every fatal instance the attack had been so slight that the children had shown no symptoms of scarlet fever, and had accordingly attended school throughout, until it became manifest that their kidneys were seriously, and, as it proved, fatally involved.

XIV. Case-Mortality.—The fatality of the disease varies in different epidemics, and at the various stages of the same epidemic. It shows a range of 3 to 30 per cent of attacks, with a probable average of 8·5 per cent. The isolation hospitals not only limit the extension of an epidemic, but concurrently reduce the case-mortality. For instance, the case-mortality in the isolation hospitals of the Metropolitan Asylums Board in 1890, with a total number of admissions of 10,343, amounted only to 2·97 per cent.

XV. Pathology.—In this zymotic disease the tissues mainly involved are those of the skin, the throat, and the kidneys; but it is not clear whether the true nidus of the streptococcus is the blood or the tissues mentioned. That the organism develops freely in the throat is evident; but as scarlet fever may exist without an eruption or sore throat, and may become fatal, as in scarlatina maligna, prior to the appearance of either of these symptoms, it would seem to be more probable that the streptococcus attacks the blood itself.

1. The characteristics of the eruption on the skin are hyperæmia and œdema of the superficial layers of the corium. The hyperæmia causes a rapid growth of the

cells of the epidermis in the rete Malpighii, and their continued reproduction entails the desquamation, which is, of course, most copious where the rash has been most intense.

2. In the throat the mucous membrane is deeply hyperæmic, which leads at first to an increased secretion of the follicles, afterwards to an exudation of lymph, and at a later stage the mucous epithelium gives way, owing to the œdema, or to the intensity of the inflammation, with the formation of an ulcer. As the inflammation progresses and the tension increases, small foci of pus arise in the substance of the tonsils. Decay of the mucous membrane, with sloughing, follows, the lymphatics and submaxillary glands become involved, and abscesses ensue.

3. In the early period of involvement of the kidney there usually occurs a fibrous and hyaline degeneration of the minute arteries and Malpighian tufts of the cortex ; while the nuclei of the epithelium covering the tuft and lining the Malpighian capsules are augmented and produce the condition known as glomerulonephritis. There also appears a parenchymatous nephritis in consequence of the epithelial cells lining some of the convoluted uriniferous tubules becoming swollen, granular, and opaque.

The kidney is hyperæmic, the capsule strips easily, leaving a bleeding surface ; and usually, in the next stage, this viscus assumes the form of the large white kidney.

The kidney subsequently diminishes in size, especially the cortex, and the capsule becomes more adherent. As the disease progresses interstitial nephritis ensues with a corresponding degeneration of the parenchyma. Contraction then takes place, and gradually the contracted granular kidney is developed.

Other changes occur in the liver, pancreas, spleen, salivary glands, and intestines ; these modifications are observable in all diseases accompanied by high fever, and consist in inflammatory hyperæmia and proliferation.

XVI. Treatment.—In a disease exhibiting so infinite a variety of types, attended by ever-varying symptoms, and involving such endless complications, it will be readily understood that the treatment must be equally diverse. No treatment is at present known that invariably disarms the poison at its onset. We can only entertain the hope that an antitoxin may be discovered that will prove equally efficacious in this fell disease as the antitoxin in diphtheria; or preferably still, that *prevention* may be secured by inoculation.

The precepts of our great master Hippocrates should especially guide our treatment when he enjoins: "To my mind he is the best physician who knows beforehand what is going to happen. By penetrating into, clearly describing the present and the future maladies of his patients, and explaining symptoms which they omit to state, he will gain their confidence." The substantial differences of symptoms and severity manifested in scarlet fever must indicate its treatment. At one time the attack is exceedingly mild, requiring care and forethought, rather than treatment; at others, terribly malignant, with a fatal result before any effective treatment can be adopted; while every variety of description may present itself between these two conditions.

The treatment must, therefore, depend upon the nature of the disease itself, the constitution of the epidemic, and the idiosyncrasy of the individual.

(i.) *Prophylactic.*—1. Quarantine.—The first essential requirement in legislation dealing with infectious diseases should be the provision of single rooms where doubtful cases can be quarantined until a definite decision upon the nature of the attack is possible. In scarlet fever an accurate diagnosis is frequently impracticable until the fourth day. The retention of such cases in their homes for this period is unwise; while their transfer to a scarlet fever ward on mere suspicion, excited by fear of the Notification Act, is iniquitous.

2. Isolation.—The stringent isolation of an accurately diagnosed case is the next important step, both on account of the patient's own welfare and the protection of the community. This isolation of the sick should extend to his nurse and attendant.

In a private house the most suitable place for the patient is usually the highest storey. The isolation should be as vigorous and complete as possible; and no visitors should be permitted to enter the sick-room. Isolation should continue until desquamation ceases on the body and limbs, that is, for a period of six to eight weeks. In cases of peeling from the palms of the hands and the soles of the feet, which so frequently endures for three or four months, complete isolation is not necessary.

3. The primary requirement in the treatment is an abundant supply of *fresh air,* without draught. The room should contain 2000 cubic feet of air space, and if other cases are treated in the same room, a floor area of 12 by 12 feet, or 144 square feet. In cold weather an open fire should be maintained, with hot-water pipes where necessary, sufficient to raise the temperature not higher than 60° Fahr. The windows should, if possible, be open night and day, varying according to the wind and weather, but without placing the patient in a draught. Where this avoidance of draught is impracticable, a window in an adjoining room or on an adjacent staircase may be available, and should never be closed day or night, as well as the door of the bedroom. The old method of hot rooms and close atmospheres has, I trust, been finally banished in the treatment of zymotic diseases.

4. Bed and Bedding.—A three-foot-wide bedstead with a wire mattress is the most convenient for nursing, on which should be placed a horse-hair mattress. Blankets, sufficient only for protection from cold, are preferable to eider-down quilts, which are too impervious. A thin flannel night-shirt, the length of the body, should be worn throughout the illness.

5. All unnecessary *furniture and hangings* should be removed from the room, together with the contents of wardrobes.

6. The *daylight* should be ample, so long as no glare falls upon the patient's eyes.

7. *Artificial light* should be reduced to a minimum, and extinguished not later than 6 P.M. in the case of children, and 8 P.M. in that of adults. There is no more reprehensible practice, in my judgment, in the treatment of acute disease, than that of permitting the patient only to settle down for the night at 10 or 11 o'clock, since the evening and the early morning are the periods during which the patient chiefly rests.

8. The *excreta* should be attended to in bed throughout the entire illness, however favourable be its type.

9. No patient, however mild the illness, should be permitted to *get up* for any purpose until twenty-one days have elapsed. This course, in my experience, prevents complications more completely than any other plan in treatment; and where it is not enforced frequent returns to bed must be made in view of complications arising.

10. Some authorities advise, with the careful avoidance of a chill, that the surface of the body should be *washed* with soap and water every morning, with tepid sponging every night.

11. Others recommend a *daily bath* as soon as the fever ceases and the strength permits.

12. Many postpone these courses of ablutions, except for purposes of cleanliness, until the close of the third week, in the belief that their tendency is to increase the frequency of affections of the kidneys; and in

substitution resort to oiling the body daily with *carbolic oil.* I concur with the advocates of this last course, which I highly recommend. But who dare assert in the treatment of scarlet fever "*post hoc ergo propter hoc.*" The oiling of the skin maintains its softness and suppleness throughout the illness. It, moreover, entangles the shed epidermis in the nightshirt and sheets, and prevents the particles being blown about the room as dust. Baths are reserved for the stage where the invalid is sufficiently recovered to leave the bed—the twenty-second day—and should be then given every night until desquamation has ceased.

13. Certain cases, however, occur of severe cerebral symptoms, active delirium, intense headache, and hyperpyrexia, where *cold sponging* or the *wet pack* is of vital value. It reduces fever, diminishes the frequency of the pulse, abates the cerebral symptoms, and induces sleep.

14. As much *cold water* to drink as the patient desires should invariably be allowed. It quenches thirst more rapidly and completely than any other drink. If water be not relished, lemon juice, in soda water with a little sugar, forms a refreshing draught. Where food is taken sparingly it may be advisable, however, to withhold these drinks, and substitute milk, or milk and soda water.

15. The patient may get up on the twenty-second day for a couple of hours; on the twenty-third day this course may be permitted twice, with a rest of two hours' duration between in the horizontal position. The length of time out of bed may be gradually extended for four days, when the patient may be allowed to go into another room for two days; and then, in suitable weather, and properly clad in flannel, out of doors.

(ii.) *Dietetic.*—The diet must necessarily be adapted in every case to the constitution of the individual, the age, the nature of the attack, its duration, and its complications. And the maxim must be observed, that it is the patient who has contracted the fever who requires the treatment, and not the fever which has seized the patient. The days when bleeding was freely resorted to in fevers, and especially in scarlet fever, when the strongest antiphlogistics were administered, when practical starvation was enforced, followed, at a later period, by saturation of the patient with alcohol as a matter of routine, are memories only of the past. All that now remains of that period of history is the practical adoption of the axiom which Graves bequeathed as his epitaph—"He Fed Fevers."

In an ordinary case of scarlet fever some such dietary rule as the following is a good working method:—

1. For the first four days the nourishment should consist exclusively of milk—not exceeding two to three pints, with as much water as is desired—with the exception, perhaps, of some lemonade and soda water.
2. For the next four days an egg and all forms of farinaceous food may be added.
3. During the ensuing four days the diet may include some weak broth, fish, fruit, and vegetables.
4. After this period poultry, game, and meat may be gradually allowed, and the food administered as freely as is desired.

In young children and adolescents the amount of food that can be consumed with impunity, where it has been withheld during the primary course of the illness, is astonishing.

When feeding has begun at an earlier stage, such as I have seen prescribed in slight cases of scarlet fever which presented no palpable illness, and where an ample diet has been strenuously demanded in con-

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sequence of appetite, the course has usually proved, in my experience, the precursor of albuminuria and other troubles.

5. Where marked anorexia exists; or where, owing to the severity of faucial ulceration, or submaxillary swelling, deglutition, in consequence of pain, is well-nigh impracticable, the food swallowed should be of the most nourishing character, such as milk, eggs and milk, raw meat juice, and chicken jelly. Stimulants may also be necessary in such instances, and must be regulated according to the age of the patient, his state of debility, and the nature of the attack. I veto all commercial preparations of "wine and meat juice," so extensively employed, since they are invariably made with very inferior wine.

6. Where food is absolutely refused administration must be effected by the nose, and the necessary mode of operation in these cases is the insertion of the tube for half an inch in one nostril, with the closure of the other, and the fluid is allowed to descend into the stomach in gulps only.

(iii.) *Curative.*—1. *The Neutralisation of the Poison.*—Until the antitoxin of scarlet fever is discovered no drug which we possess can be said to be absolutely reliable. Various drugs for this purpose have been advocated from time to time. Personally I have found the biniodide of mercury efficacious, not only in arresting the fever, but in minimising the desquamation, and reducing the duration of the illness, and the necessary isolation. But it would require more extended experience than mine, in a disease like scarlet fever, to affirm that a causal connection exists between this treatment and the result. Other physicians have also adopted the sulpho-carbolates and the hypo-sulphites with apparent advantage.

2. *The promotion of elimination of the fever poison.*

(*a*) The primary requirement in the treatment of all fevers is the unloading of the alimentary canal at the start; for this course alone, by increasing the action of the excreting organs, will often at once convert an apparently serious illness, commencing with alarming symptoms, into one of a milder type.

This procedure must be effected in scarlet fever with caution, on account of the tendency to vomiting and diarrhœa at the onset, which sometimes form ominous symptoms in the anterior stage, and invariably so at later periods. Aperients, therefore, should generally be avoided during the earlier history of scarlet fever. This does not affirm that they should be absolutely dispensed with, but simply that they should be employed with judgment and caution. A simple enema is sometimes the least injurious remedy; but a saline aperient, a small dose of a mercurial, or of liquorice powder, may be necessary, and will be found to be safe.

(*β*) *Febrifuges.*—A mixture of a saline nature, such as acetate of ammonia, accompanied by nitre, or nitric ether, or chlorate of potash, where the throat is much involved, is desirable.

3. *The Reduction of Temperature, and of the Frequency of the Heart's Action.*—Where the temperature is unusually high, and the pulse frequency excessive, tepid or cold sponging, and the use of the wet pack, are sometimes of incalculable value.

4. *The Improvement of the Condition of the Blood.*—As marked anæmia sometimes attends, or follows scarlet fever, the use of iron and arsenic is indicated at a later stage.

5. *The relief of distressing symptoms.*

(*a*) Troublesome affections of the *nervous system* are the first to appear, and comprise headache, delirium, convulsions, restlessness, and insomnia. These are greatly relieved by tepid sponging or the wet pack. A small dose of Dover's powder, varying according to age, is useful for young patients; and of paraldehyde, phenazonum, sulphonal, or the bromides for older ones.

(β) Where *hyperpyrexia* occurs, the cold affusion or the wet pack, as I have already stated, possesses the greatest value in these desperate cases, which eventually, however, are too frequently fatal.

(γ) Symptoms affecting the *throat* are the most distressing of all to the patient, and demand immediate assistance for their relief. The greatest benefit is derived from *hot* drinks. All food should be administered in this form; and the facility and ease of swallowing them are astonishing. Sucking ice is also agreeable. Gargling, inhaling, and spraying the throat with antiseptics, such as permanganate of potash, boracic acid, and sulphurous acid, afford material aid where the strength permits their employment. A local wet pack or hot fomentations to the throat also produce relief. In sloughy, ulcerated, foul throats, chlorine water (called euchlorine), locally applied, as well as swallowed, is of the greatest service.

(δ) Where the *submaxillary region* is enormously swelled, early incisions not only relieve instantly, but may also prevent suppuration.

(ε) *Adenitis.*—The same observation applies to inflammation of glands.

(ζ) *Otitis* commences with earache, which can be relieved by gentle syringing with hot water, followed by opium, atropine, or cocaine applied in the ear. Mustard, applied behind the ear, sometimes arrests the inflammation when employed early. When the pain is severe, and the temperature high, the application of leeches in front of and behind the ears speedily removes the pain and arrests further mischief. If, however, suppuration supervene, incision of the tympanum is called for; while, if perforation occur, irrigation with antiseptics such as boracic acid is essential, followed by insufflation of dry boracic acid or iodoform. If the mastoid become tender or reddens, an early incision through the periosteum, or even gouging, should be effected without hesitation.

(η) *Diarrhœa* may require treatment, either by starch and opium injections or by opium and bismuth given internally.

(θ) *Rheumatism* may demand treatment with salicylates, liniments, or blisters; and if suppuration of a joint supervene, an incision, with antiseptic precautions, should be made.

(ι) *Albuminuria.*—Where simple albuminuria arises in the course of scarlet fever a prolonged stay in bed is requisite, and a milk and farinaceous diet should be prescribed. Where, however, simple albuminuria exists from the onset no significance may possibly be indicated beyond a hyperæmia of the kidneys; even in these cases, nevertheless, the preceding course is advisable.

(κ) *Acute Nephritis.*—In this acute attack, accompanied by hæmaturia and scanty urine, the kidneys should be rested through action upon the skin and bowels, and by aiding the reduction of arterial tension.

(1) As regards the *skin,* hot air and vapour baths, hot wet pack, and hot drinks should be employed.

(2) As regards the *bowels,* bitartrate of potash, Epsom salts, and compound jalap powder should be used.

(3) *Arterial tension* may be efficiently relieved by nitro-glycerine or erythrol-tetranitrate, by leeches, wet-cupping, venesection, and, where the urine is suppressed, an incision through the capsule of the kidney itself may save life. If convulsions occur, morphia or chloroform may be required. If pulmonary œdema arise, venesection, sufficient to relieve the right side of

the heart, may be necessary, together with the administration of digitalis and nux vomica. When relief has been afforded to the kidneys their normal functions are resumed, the hæmaturia disappears, and the headache and vomiting cease. For this purpose iron, in conjunction with sulphate of magnesia, is very efficacious. If recovery take place a prolonged stay in bed, clothed in flannel, is essential, followed by residence in a warm, dry climate.

(λ) *Ataxic Symptoms.*—Where these symptoms arise carbonate of ammonia, musk, and alcohol are imperative; transfusion, or hot saline injections, may prove of service.

(μ) *Eczema.*—Where eczema occurs at the orifices of the mouth, nose, and ears, hot boracic lotion alleviates rapidly, and may be followed by the application of oleate of zinc or boracic ointment.

(ν) *Ulcerative Stomatitis.* — In mild cases of this description alkalies and opium bestow relief; but in severer forms the local use of euchlorine should be adopted. And if the inflammation proceed to noma, fuming nitric acid, after an anæsthetic, is indispensable.

(iv.) *Convalescents.*—On the termination of the illness the patient, in mild cases, is perfectly well, and requires no further care. But the state of health after an attack of the severe type may demand the most assiduous treatment on account of the condition of the blood and the state of the kidneys, throat, and ears. A sojourn of many months in a warm, dry climate may be essential to complete recovery.

(v.) *The Limitation of the Disease.*—We have hitherto discussed those points only which relate to the treatment of the individual attacked. In consequence, however, of the infectious nature of the disease, and its frequently epidemic character, a few words are necessary with reference to the protection of those who are not already infected. These I shall offer in the form of suggestions only, without discussion of the detailed method of procedure.

1. *Notification.*—The value of *notification*, in addition to its use for statistical purposes, consists in securing the isolation of the sick person and the nurse.

2. *Disinfection.*—A. *Disinfection* DURING *Illness.*

(α) All the excreta, expectoration, urine, and excrement should be received into vessels containing perchloride of mercury, or one of the tar derivatives. The nasal secretion should be excreted into pieces of linen which should be immediately burnt.

(β) The body, in all cases, should be washed sufficiently for purposes of cleanliness.

(γ) The body linen and the bed linen should be changed as often as may be requisite for cleanliness. It should be received into vessels containing a disinfectant as soon as removed from the patient, and before it leaves the room.

(δ) The nurse's linen and clothes should be subjected to similar treatment to that adopted for the patient's.

(ε) The room should be rubbed over daily with a damp cloth wrung out in a disinfectant.

B. *Disinfection* AFTER *Illness.*

(α) Disinfecting *baths* are necessary for many days before the patient is allowed full liberty.

(β) Fresh *clothes* should be worn before this liberty is granted. But where a disinfecting chamber is available that plan of disinfection may be safely adopted.

The patient should enter a bath-room for the purpose of disinfecting his body, and his clothes can meanwhile be passed through the steam disinfector, and come out on the other side into a fresh room where the patient can receive and assume them, taking his departure thence.

(γ) But I do not regard any disinfection to be sufficiently safe to enable the patient to be discharged when, up to the time of his discharge, he has been in communication with *recent cases of scarlet fever.* In my opinion, it is under such circumstances, unless gross carelessness has occurred in the disinfecting arrangements, and a want of scrupulous conscientiousness in their execution, that return cases of scarlet fever arise, besides those where discharges from the ears, nose, mouth, and vagina are still proceeding.

(δ) The whole of the *bedding* of patient and nurse should also be passed through the steam disinfector.

(ε) The infected room requires efficient disinfection. The paper should be stripped, the ceiling whitewashed, and the paint, floor, and furniture washed with carbolic solution. Sulphur should also be burnt, as it permeates into every crack and crevice, or formalin sprayed. After this process has been completed, and no articles of clothing have escaped the disinfecting chamber, the room should be exposed, day and night, to a cross draught of fresh air for several days.

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